OPERATING AND SERVICE MANUAL

SIGNAL SOURCES

8614B AND 8616B

HEWLETT hp PACKARD

8614B/8616B

HEWLETT hp PACKARD

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

MODEL 8614B
AND
MODEL 8616B

SIGNAL SOURCES

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HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODIFICATIONS

SPECIFICATION H05-8614B

UHF SIGNAL SOURCE

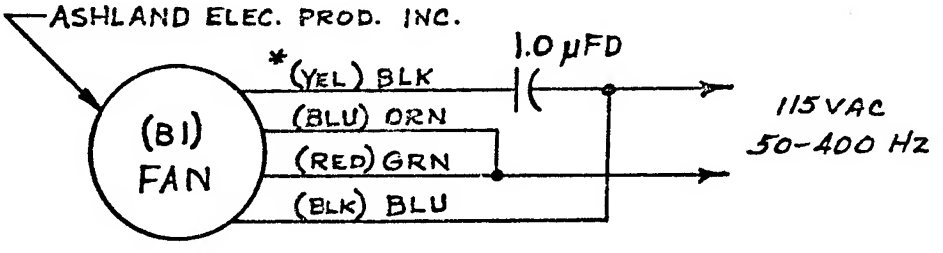
The H05-8614B is similar to the standard HP Model 8614B Signal Source except that it may be operated from main power lines having a frequency between 50 and 400 cycles per second, at 115 or 230 volts.

To accomplish this modification the cooling fan motor has been replaced with a variable frequency unit. Because the physical length of the new fan motor and fan is longer than the standard, the overall depth of the instrument has been increased by approximately one inch. To insure adequate cooling allow at least several inches of free, well-ventilated air space at the rear of the cabinet.

The replacement motor carries the HP Stock Number 3140-0015. The split-phase starting capacitor is a 1.0 microfarad tubular mylar rated at 600 volts. It carries the HP Stock Number 0170-0073. The added wiring is shown in the partial schematic below.

When ordering replacement parts refer to the Specification H05-8614B as well as giving the complete description and circuit reference (if any) of each part being ordered.

In all other respects the H05-8614B is the equivalent of the standard HP Model 8614B and the Operating and Service Manual supplied with this special version will apply.



*NOTE: WIRE COLORS IN PARENTHESES REFER TO SINGER FAN MOTOR ONLY. USE 0.5 μFD CAPACITOR, HP STK NO. 0160-0024, WHEN INSTALLING THIS MOTOR.

Encl: 8614B

wm/1169

12-8-00000

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Figure 1-1. Model 8614B Signal Source

Table 1-1. Specifications

FREQUENCY RANGE:
8614B: 800 to 2400 Mc; single, linearly calibrated control, direct reading within 2 Mc.
8616B: 1800 to 4500 Mc; single, linearly calibrated control, direct reading within 2 Mc.

VERNIER:
ΔF control has range of about 2 Mc for fine tuning.

FREQUENCY CALIBRATION ACCURACY:
8614B: ±5 Mc or ±1/2%, whichever is greater
8616B: ±10 Mc

FREQUENCY STABILITY:
Approximately 0.005%/°C change in ambient temperature, less than 0.0003% (6 kc - 8616B) peak residual FM, less than 0.003% change for line voltage variation of ±10%.

RF OUTPUT POWER:
8614B: At least 15 mw controlled by attenuator
8616B: At least 15 mw (up to 3 Gc) controlled by attenuator; at least 3 mw (3 Gc to 4.5 Gc) controlled by attenuator.
8614B/8616B: A second RF output provides at least 0.5 mw.

ATTENUATOR ACCURACY:
±0.06 db/10 db (-10 to -127 dbm); direct reading linear dial, 0.2 db increments. Backlash<0.2 db.

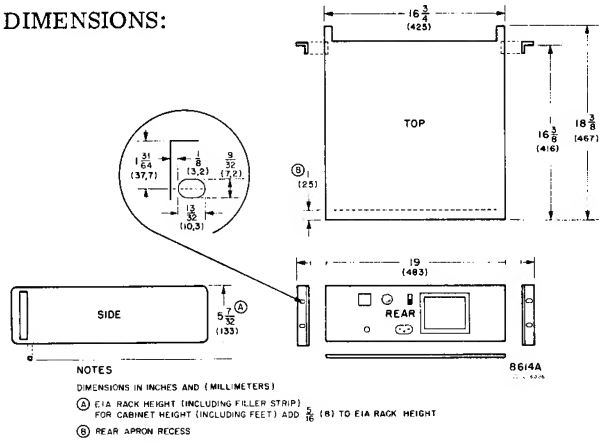
INTERNAL SQUARE-WAVE MODULATION:
950 to 1050 cps. Can be synchronized with +1 volt pulse input.

EXTERNAL PULSE MODULATION:
50 cps to 500 kc; minimum RF pulse width 300 nsec; +25 to +50 volts peak input.

EXTERNAL FM MODULATION:
(a) Front-panel connector capacitively-coupled to klystron repeller. Input impedance, 220K shunted by about 300 pf.
(b) Rear-panel connector is DC-coupled to klystron repeller.
Mode width between 3-db points varies as follows:
Model 8614B: From about 4 Mc at 800 Mc to about 15 Mc at 2000 Mc; klystron sensitivity is about 100 kc/volt from 800 to 1600 Mc and 200 kc/volt from about 1600 to 2400 Mc.
Model 8616B: From about 5.5 to 4 Mc from 1800 to 3000 Mc and from about 8.5 to 5.5 Mc from 3000 to 4500 Mc; klystron sensitivities are about 100, 50, 200, and 100 kc/volt respectively.

POWER SOURCE: 115 or 230 volts ±10%, 50 to 60 cps, approximately 100 watts.

DIMENSIONS:



WEIGHT: Net 37 lb (16,7 kg); shipping 42 lb (18,9 kg)

SUPPLIED: 7-1/2 foot (2290 mm) power cable with NEMA plug; rack-mounting kit.

OPTION 01: Input connectors on front and rear panels; RF connectors on rear panel only.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The Model 8614B and 8616B Signal Sources provide RF power in the 800- to 2400-Mc and 1800- to 4500-Mc range, respectively. Each instrument has two power output connectors which supply RF power simultaneously. One output provides at least 15 milliwatts (2 mw for 8616B from 3.0 to 4.5 Gc) over a range of about 140 db with a precision attenuator. The other output connector provides an uncalibrated output of at least 0.5 milliwatts which can be used for phase locking the source when extreme stability is desired, or it can be monitored with a frequency counter for extreme frequency resolution. Fine frequency changes can be made by means of the front-panel ΔF control and the attenuator dial can be set to any convenient reference while output power is held constant. Complete specifications are given in Table 1-1. The Model 8614B is shown in Figure 1-1.

1-3. Since both the Models 8614B and 8616B Signal Sources are the same in most respects, this manual will discuss the instruments in terms of the Model 8614B. The Model 8616B will be mentioned only where it differs from the Model 8614B Signal Source.

1-4. The internally square-wave modulated output can be externally synchronized to a 1-volt positive pulse signal. In addition, the RF power can be externally FM or pulse modulated. An external DC-coupled FM input which can be used for external AFC is also provided.

1-5. SUPPLEMENTARY INFORMATION.

1-6. Two instruments capable of extending the operation parameters of the source are the hp Model 8714A (hp Model 8716A for the Model 8616B) and the Dymec Model 2654A. The Models 8714A and 8716A Modulators produce output pulses with 20-nanosecond rise and decay time characteristics and have an 80-db on-off ratio. Pulse outputs are accurately variable in frequency, width, and delay. Amplitude modulation is available with frequency response to 10 Mc for sine waves. Square-wave frequency capability is accurately available. The modulators also provide sync and delayed-sync outputs.

1-7. The Dymec Model 2654A Frequency Standard Synchronizer may be used directly to stabilize all internal cavity reflex klystron signal sources. The Model 2654A virtually eliminates any short-term drift in RF output signal and provides degeneration for any incidental FM in the output signal.

1-8. INSTRUMENT OPTIONS.

1-9. In addition to the standard Model 8614B, the Option 01 is available. The Option 01 instrument has its input connectors located on both the front and rear panel and its output connectors located on the rear panel; in all other respects it is the same as the regular Model 8614B.

1-10. INSTRUMENT IDENTIFICATION.

1-11. Hewlett-Packard uses a two-section eight-digit serial number (000-00000). The first three digits, or the serial prefix, are for the purpose of matching published material to the instrument. If the serial prefix on your instrument does not appear on the title page of this manual, there are differences between the instrument described and your instrument. These differences are listed in a change sheet included with the manual. If the change sheet is missing, the information can be supplied by your nearest Hewlett-Packard field office.

1-12. KLYSTRON WARRANTY CLAIM SHEET.

1-13. The klystron supplied with the Model 8614B and replacement klystrons purchased from the Hewlett-Packard Company are guaranteed by the manufacturer against electrical failure for a specified period of time (time from date of purchase or hours of operation); warranty conditions vary with the type of tube used. Thus, for the actual warranty period of the klystron in your instrument, contact your local hp field office. A sheet for your use is included in the appendix of this manual; follow the instructions on the sheet explicitly.

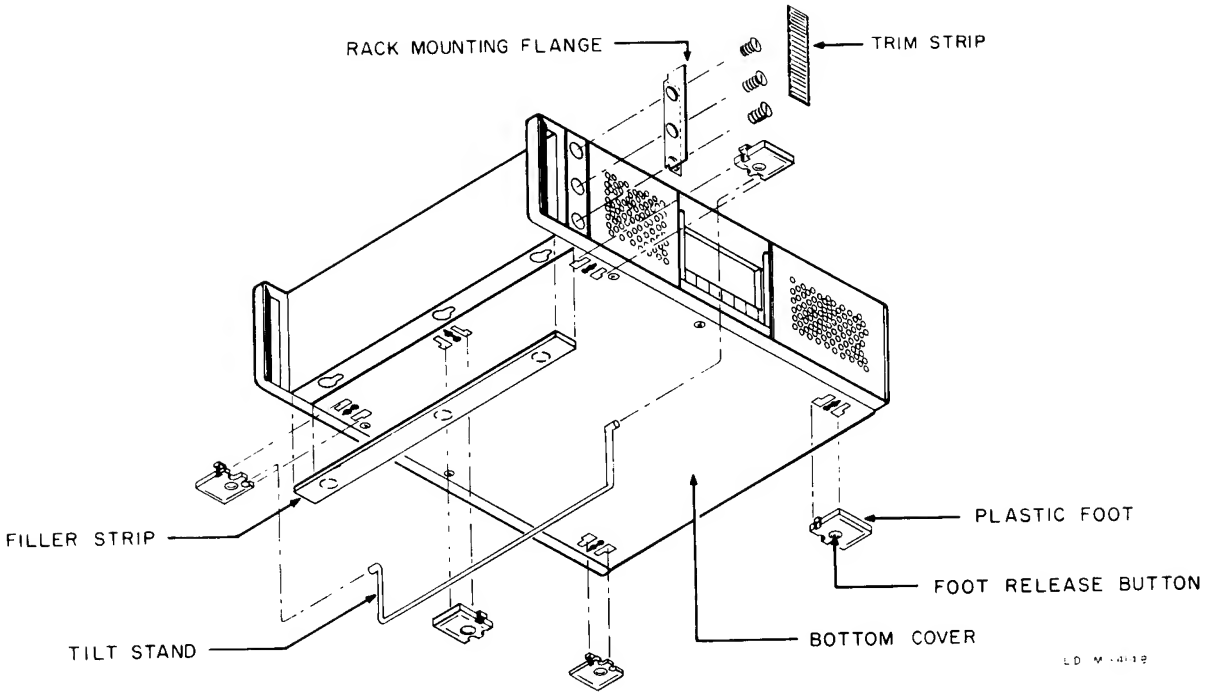


Figure 2-1. Conversion to Rack Mount

SECTION II
INSTALLATION

2-1. INCOMING INSPECTION.

2-2. This instrument was inspected both mechanically and electrically before shipment. To confirm this, the instrument should be inspected for physical damage in transit. Also check for supplied accessories, and test the electrical performance of the instrument, using the procedure outlined in Paragraph 5-44. If there is damage or deficiency, see the warranty on the inside rear cover of this manual.

2-3. INSTALLATION.

2-4. The Model 8614B is delivered as a cabinet mount instrument. A kit is supplied with the instrument for conversion from cabinet to rack mount.

Note

The instrument is electrostatically shielded but, not magnetically shielded. Hence, a magnetic field near the instrument cover can cause excessive, incidental FM in the output signal. To eliminate this problem a metal shield with high permeability, such as a sheet of silicon steel, must be placed between the 8614B and any instrument radiating a magnetic field.

2-5. Whether the instrument is cabinet- or rack-mounted, provision should be made for adequate circulation of air around the instrument. The instrument cooling fan is located at the rear of the instrument and louvers are located on instrument side panels. Proper air circulation is most important at the sides and rear of the instrument.

CAUTION

IF FAN IS NOT OPERATING, THE INSTRUMENT SHOULD NOT BE OPERATED.

2-6. CONVERSION TO RACK MOUNT.

a. Remove trim strip on sides of instrument (refer to Figure 2-1).

b. Remove tilt stand by pressing two sides of stand toward center of instrument and lifting it out.

c. Remove five feet at bottom of instrument. Press button in center of each foot, slide them toward center of instrument, and lift out.

d. Place rack mounting flanges (two) where trim strips were and secure with screws provided.

e. Add filler strip to bottom of instrument.

f. Rack mounting under severe vibration conditions must be supplemented with additional support at rear

2-7. AIR FILTER INSPECTION.

2-8. The 8614B uses forced-air cooling to maintain tolerable temperature within the instrument. Incoming air is filtered through a special filter at the rear of the instrument. The air filter should be checked periodically and if dirty, cleaned. Refer to Paragraph 5-3 for air filter maintenance.

2-9. POWER REQUIREMENT.

2-10. The 8614B can be operated from a 115- or 230-volt, 50- to 60-cps source. A two-position slide switch (LINE VOLTAGE) at the rear of the instrument selects AC operation mode. The line voltage at which the instrument is set to operate appears on the slider of the switch. A 1-1/2-ampere standard fuse is used for 115-volt operation; a 3/4-ampere standard fuse is used for 230-volt operation.

2-11. THREE- CONDUCTOR POWER CABLE.

2-12. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-13. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-14. REPACKAGING FOR SHIPMENT.

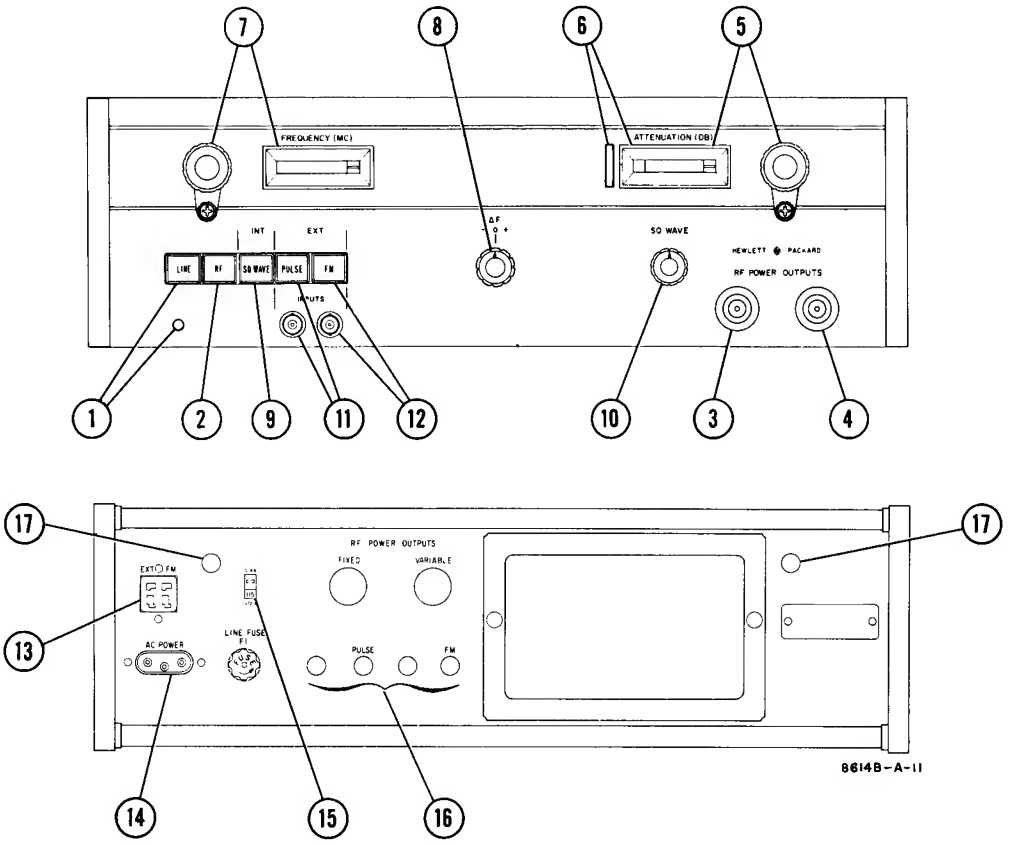
2-15. The following list is a general guide for repackaging an instrument for shipment. However, if you have any questions, contact your local hp field office.

a. If possible, use the original container designed for the instrument. If a carton and packing materials are desired, they can be ordered from your local hp field office.

b. The instrument is supported by four polyethylene supports fitted to the instrument height: one support located at each corner.

Note

If the instrument is to be shipped to the Hewlett-Packard Company for service or repair, attach to the instrument a tag identifying the instrument by owner, model, and full serial number, and indicating the service or repair to be accomplished. In any correspondence refer to the instrument my model number and complete serial number including the three-digit prefix.



1. LINE. Connects primary power to instrument; lamp glows.

2. RF. Applies power to RF POWER OUTPUTS.

3. VARIABLE RF POWER OUTPUT.

4. FIXED RF POWER OUTPUT. Provides at least 0.5 mw and unattenuated RF power.

5. ATTENUATION (DB). Sets relative RF power level at VARIABLE RF POWER OUTPUT.

6. Thumb wheel. Sets attenuation (DB) dial to any convenient reference without changing VARIABLE power output.

7. FREQUENCY (MC). Sets RF frequency.

8. ΔF. Permits small deviations from FREQUENCY (MC) setting (±2 Mc maximum).

9. INT SQ WAVE. Modulates RF POWER OUTPUTS.

10. SQ WAVE (FREQ.) control adjusts modulation frequency.

11. EXT PULSE. Positive pulses to external pulse input will provide modulation voltages required to pulse modulate RF POWER OUTPUTS. Positive pulses turn RF "ON".

12. EXTERNAL FM. AC voltages applied to external FM input will provide frequency modulation of both FIXED and VARIABLE outputs.

13. EXT FM. DC coupled input to klystron for frequency stabilization.

14. POWER. Male receptacle which connects to the power cord.

15. LINE VOLTAGE. Arranges input power transformer to accept either 115- or 230-volt, 50- to 60-cps primary power input.

16. OPTION 01. Input and output connectors located on rear panel (input connectors also located on front panel).

17. Optional extension of attenuator or frequency shaft for rear panel servo drive arrangement: available upon special request.

Figure 3-1. Front and Rear Panel Controls and Indicators

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. The Model 8614B Signal Source can provide RF power up to at least 15 milliwatts at frequencies from 800- to 2400-Mc (1800- to 3000-Mc for the Model 8616B Signal Source). It provides internal square-wave modulation that is variable in rate from 950 to 1050 cps (other frequencies are available upon request). In addition, external FM and pulse modulation voltages can be applied. Two or three modulation modes of operation can be applied to the instrument simultaneously; pushbutton controls select the mode of operation. External modulation inputs are located directly below the modulation button to which they apply.

CAUTION

RF power in excess of approximately 125 mw should never be applied to RF power output connectors as internal damage could result.

3-3. FRONT AND REAR PANEL CONTROLS AND INDICATORS.

3-4. Functions of all front and rear panel controls and indicators are given in Figure 3-1. The function of each control and indicator is keyed to the illustration of the instrument front and rear panels which appears in Figure 3-1.

Note

Depressing the EXTERNAL PULSE button without the application of an external signal cuts-off the RF output power.

3-5. OPERATING PROCEDURES.

3-6. The operating procedures (Figures 3-2 through 3-5) give set up procedures for the various modes of operation. Instructions are given for obtaining the following outputs: CW (unmodulated), square-wave modulated (modulating voltage supplied internally, and FM, and pulse-modulated (modulating voltage supplied externally).

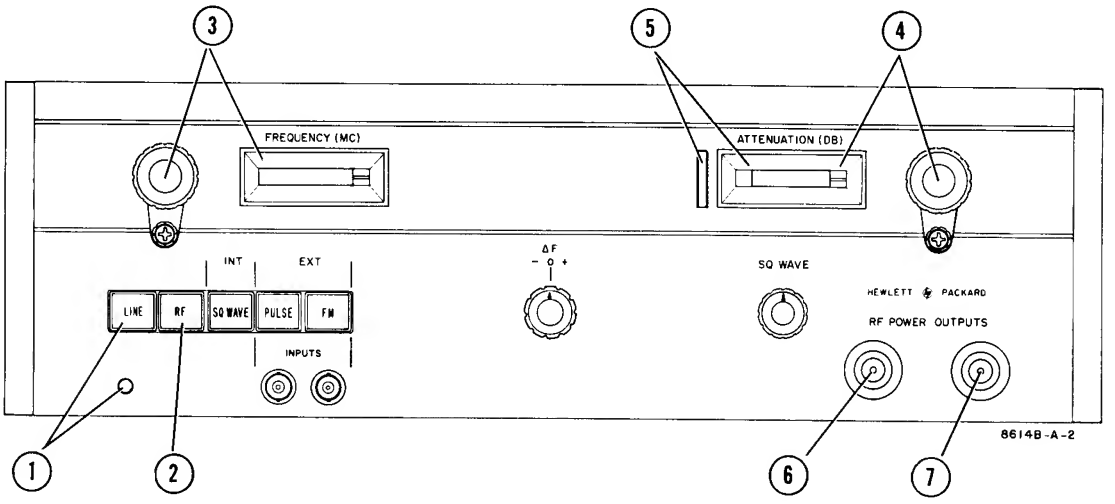
3-7. STABILIZED SOURCE.

3-8. To use the Dymec 2650A Oscillator Synchronizer with the Signal Generator, proceed as follows:

a. The rear panel connector EXT FM (J201) is a Cinch-Jones type S304AB. Connection between this jack and J5 of the Dymec 2650A must be made as follows:

Pin 3, J201, to Pin E, J5, 2650A
Pin 4, J201, to Pin F, J5, 2650A
Pin 1, J201, to Pin G, J5, 2650A
Pin 2, J201, no connection

b. Connect RF output from UNCAL OUTPUT connector on Model 8614/8616 to OSCILLATOR INPUT connector on Model 2650A. Depress EXTERNAL FM button on Model 8614/8616 and proceed as explained in the instruction manual for the Model 2650.

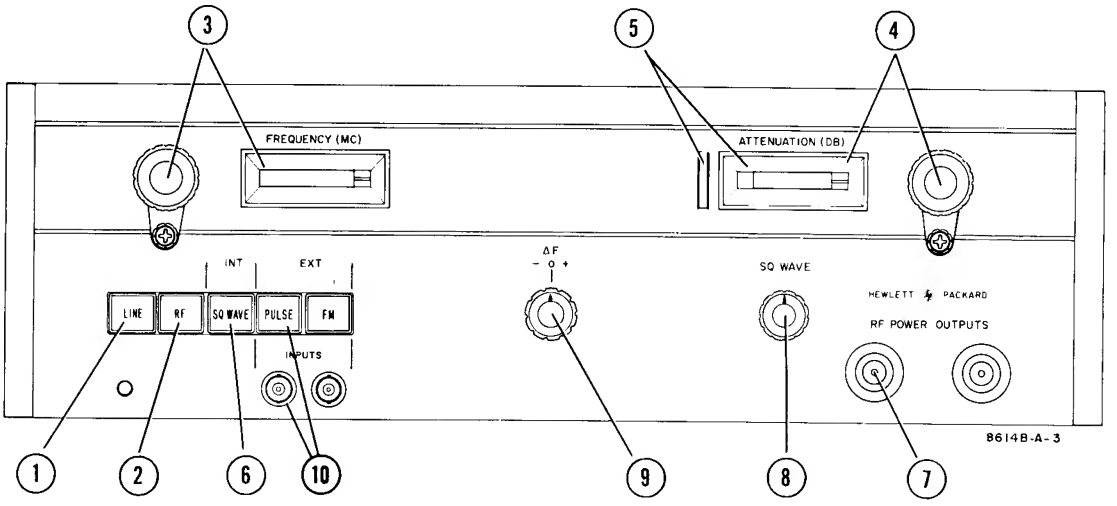


1. Depress LINE; lamp glows, indicating heater and high voltage are applied.
2. Depress RF.
3. Set FREQUENCY (MC) to desired frequency.
4. The ATTENUATION (DB) knob will attenuate RF power at variable RF POWER OUTPUT.
5. The thumb screw adjustment will set ATTENUATION (DB) dial to any convenient reference without affecting output power level.
6. Take attenuable RF power at variable RF POWER OUTPUT.
7. Take unattenuable RF power at FIXED RF POWER OUTPUT.
8. Use ΔF control when a small deviation from FREQUENCY (MC) setting is desired.

Note

ΔF control should be centered when not in use.

Figure 3-2. Unmodulated RF Power Output

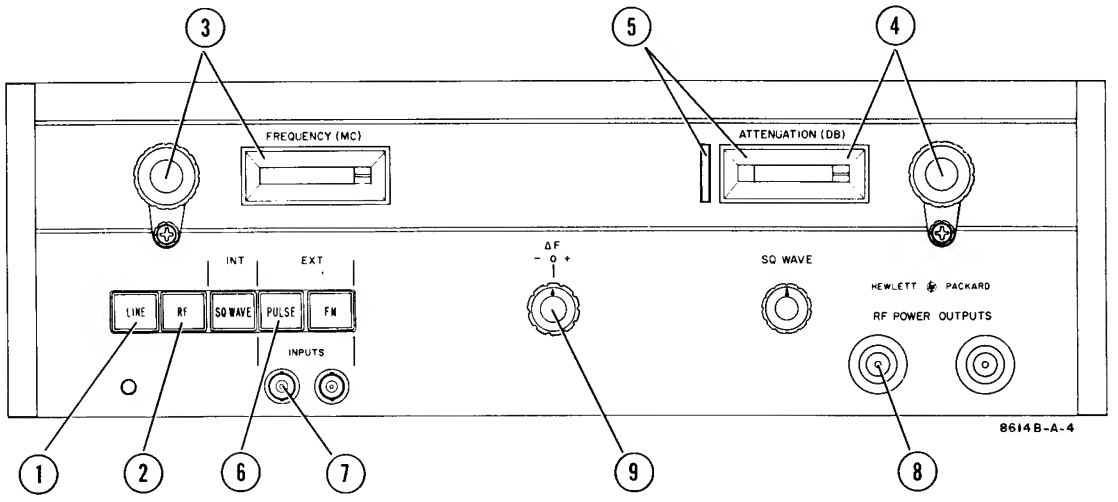


1. Depress LINE.
2. Depress RF.
3. Set FREQUENCY (MC).
4. Set output level with ATTENUATION (DB) knob.
5. Set ATTENUATION (DB) dial to any convenient reference with thumbscrew adjustment.
6. Depress SQ WAVE.
7. Take modulated and attenuable RF power output at variable RF POWER OUTPUT.
8. Adjust SQ WAVE for desired modulation frequency.
9. Use ΔF control when a small deviation from FREQUENCY (MC) setting is desired.

   Note: ΔF control should be centered when not in use.

10. EXTERNAL SYNCHRONIZATION.
    a. Depress PULSE and apply +1 volt pulse;
    b. Pulse repetition rate must be between 955 and 1100 cps, which will be synchronizing frequency;
    c. Decrease SQ WAVE FREQ to a rate slightly slower than the pulse repetition rate.

Figure 3-3. Internal Square-Wave Modulation and External Sync

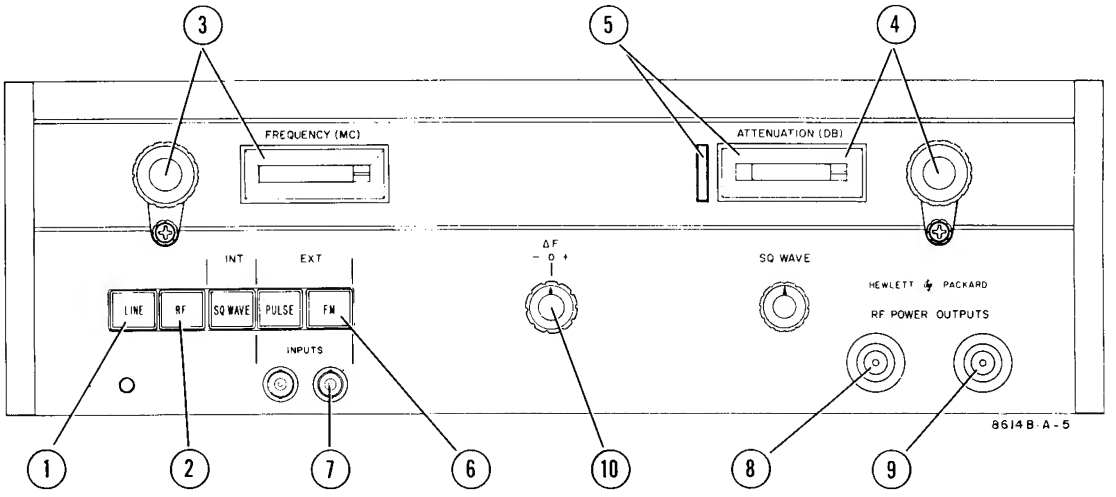


1. Depress LINE.
2. Depress RF.
3. Set FREQUENCY (MC).
4. Set output level with ATTENUATION (DB) knob.
5. Set ATTENUATION (DB) dial to any convenient reference with thumb screw adjust.
6. Depress EXTERNAL PULSE.
7. Apply +25 - to +50-volt 50-cps to 1/2-Mc positive pulse modulating signal to EXT PULSE INPUT.
8. Take pulse modulated and attenuable RF power output at VARIABLE RF POWER OUTPUT.
9. Use ΔF control when a small deviation from FREQUENCY (MC) setting is desired.

Note

ΔF control should be centered when not in use.

Figure 3-4. External Pulse Modulation



1. Depress LINE.
2. Depress RF.
3. Set FREQUENCY (MC).
4. Set output level with ATTENUATION (DB) knob.
5. Set any convenient reference on ATTENUATION (DB) dial with thumb screw.
6. Depress EXTERNAL FM.
7. Apply modulating signal to EXT FM INPUT (front panel).
8. Take attenuable frequency modulated RF power output at VARIABLE RF POWER OUTPUT.
9. Take unattenuable frequency modulated RF power at FIXED RF POWER OUTPUT.
10. ΔF control should be centered so that the klystron will operate in the center of the mode.

Figure 3-5. External FM

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. Basically the instrument includes a Modulator, RF Oscillator, and a Power Supply, as shown in Figure 4-1. The RF Oscillator is a reflex klystron which supplies RF power. The Modulator provides the video pulses required to pulse and square wave modulate the klystron output. The power supply provides the regulated DC voltages required to operate the instrument.

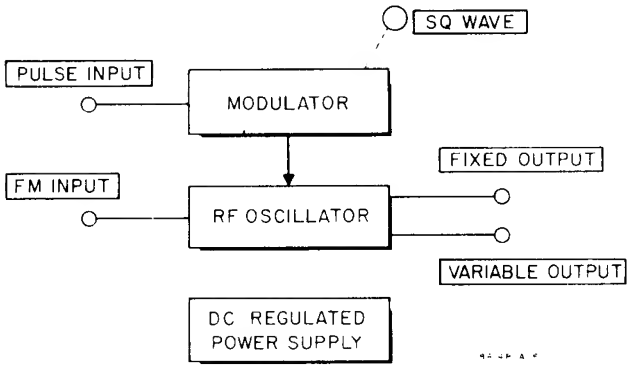


Figure 4-1. Circuit Block Diagram

4-3. MODULATOR CIRCUITS.

4-4. The basic function of the modulator circuits is to provide a positive video pulse to the control grid of the klystron, V1. This drives the control grid positive which allows the klystron to oscillate during the time of the pulse. The arrangement of the modulator circuit depends upon the mode of operation. Mode of operation selection is accomplished by depressing the appropriate front-panel button.

4-5. EXTERNAL PULSE.

4-6. A simplified diagram of the circuits used in the external pulse mode of operation is shown in Figure 4-2. When the pulse button is depressed, V401A is cut-off, and V401B starts conducting. Conduction causes the plate voltage of V401B to drop to approximately -50 volts which impresses a voltage of less than -320 volts on the emitter of transistor Q401. Emitter Followers Q401 and Q402 begin to conduct heavily and a voltage of less than -320 volts is impressed on the control grid of the klystron. This voltage which is more negative than the cathode of the klystron causes klystron oscillation to cease. When a positive pulse, of at least +25 volts, is applied to the external pulse input the emitter potential of transistor Q401 is raised to a voltage positive with respect to the cathode of klystron V1. This voltage is applied to the control grid of the klystron causing the klystron to oscillate for the time of the positive pulse.

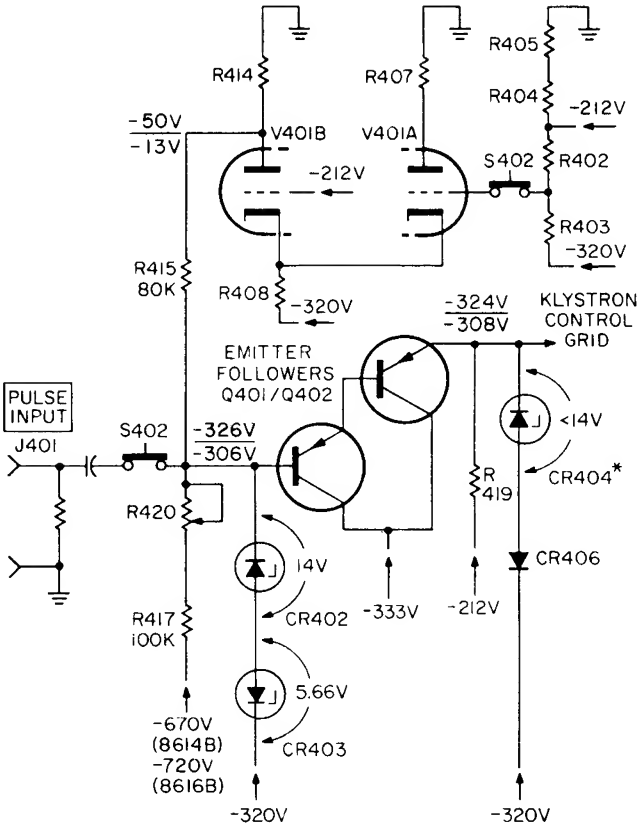


Figure 4-2. Pulse Modulation Circuit

4-7. INTERNAL SQUARE WAVE.

4-8. A simplified diagram of the circuit arrangement for internal square wave operation is shown in Figure 4-3. With the square wave button depressed, when V401A is cut-off and V401B is conducting the voltage on the plate of V401B is approximately -50 volts. A voltage of -50 volts on the plate of V401B causes a voltage on the emitter followers which is negative with respect to the cathode of the klystron. This voltage applied to the control grid of the klystron causes klystron oscillation to cease. With V401B conducting, capacitor C402 is discharging towards approximately -200 volts (the voltage at potentiometer R410). When C402 discharges enough to bring V401A into conduction, V401B is biased off through the common cathode resistor R408. When V401B is cut-off, the tubes plate voltage rises to about -13 volts which results in a voltage on the emitter followers which is more positive than the -320 volt klystron cathode voltage. This voltage applied to the control grid of the klystron causes the klystron to oscillate. With V401A conducting the voltage at R410 drops to about -225 volts and C402 begins to charge toward about -225 volts. When C402 charges to a voltage more negative than the cathode of

V401A, current in V401A becomes limited and V401B again conducts causing the klystron to cease oscillation. The RC time constant of C402 is varied by R413, allowing modulation frequency to be changed from at least 950 to 1050 cps. When V401B is conducting the RF output of the klystron is cut-off. The symmetry of the square wave is adjusted by R410. The potential to which C402 charges or discharges is controlled by varying R410.

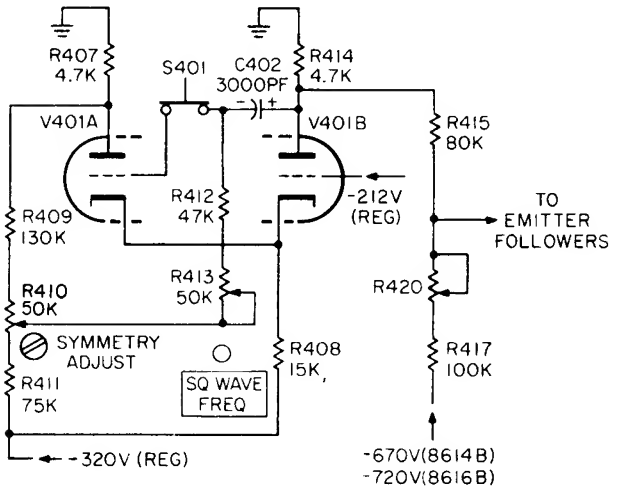


Figure 4-3. Square Wave Modulation Circuit

4-9. SYNCHRONIZED SQUARE WAVE.

4-10. With the SQ WAVE and PULSE depressed and no signal applied to the pulse input, operation is as described in paragraph 4-8. A positive pulse signal, of at least 1 volt, applied through CR405 causes the cathode of V401A to go positive which limits tube current; V401B begins to conduct causing the klystron to cease oscillation. Any input signal applied while V401B is conducting will not affect normal square wave circuit operation. Square wave modulation frequency may be synchronized to any pulse repetition rate between about 955 to 1050 cps providing internal modulation frequency is set to a slightly slower rate.

4-11. RF OSCILLATOR.

4-12. The RF Oscillator is a reflex klystron tube mounted in a plunger tuned cavity for generation of the RF energy. The energy from the cavity is coupled by means of pickup probes located in small sections of waveguide which open into the cavity. The energy from these two probes is coupled directly to the RF OUTPUT connectors. One of the probes is adjustable in depth into and out of the cavity allowing the energy level coupled to the VARIABLE RF OUTPUT connector to be variable.

4-13. REFLEX KLYSTRON OPERATION.

4-14. The resonant circuit of the RF Oscillator klystron includes resonator-grid capacitance, and the primarily inductive impedance of the external cavity. The cavity is a shorted coaxial transmission line, one cylinder within another. The cavity is fitted with a movable plunger (wiper contacts which short-circuit the line at the opposite end of the cavity from the tube) which change cavity dimensions. Changing cavity dimensions changes the resonant frequency of the oscillator circuit. Thus changing the frequency of oscillation.

4-15. Figure 4-4 shows the equivalent circuit of a reflex klystron oscillator. In the following discussion of how oscillations are sustained in a reflex klystron oscillator, the presence of a low amplitude rf voltage across the resonator grids is assumed. As in any oscillator, this initial voltage is supplied by the thermal agitation noise.

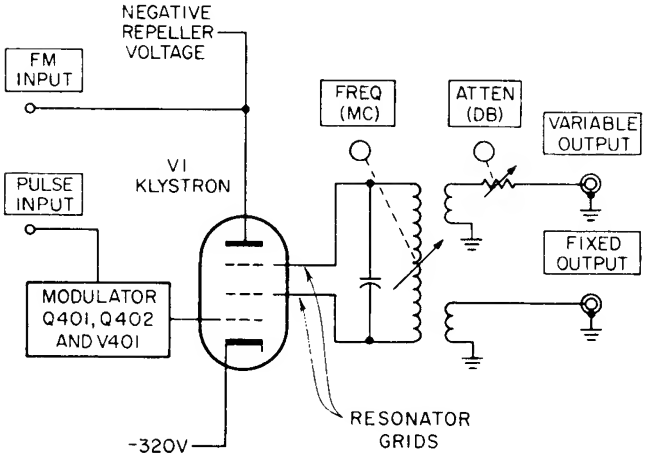


Figure 4-4. Equivalent Oscillator Circuit

4-16. Electrons emitted from the cathode toward the resonator grids are velocity modulated, i.e., the electrons are accelerated or decelerated according to the phase of the rf voltage existing across the resonator grids. After leaving the resonator grids, the electrons encounter a retarding electric field set up by the negative repeller voltage and are repelled back toward the grids. Since the electrons have been velocity modulated they tend to form in bunches when they arrive at the grids.

4-17. This bunching of electrons is illustrated in Figure 4-5, which shows the transit time relationship of electrons while in the drift space between the resonator grids and the repeller. Consider an electron (a) leaving the grids at time t_1. The voltage of the RF signal on the grids is such that the electron receives energy and is accelerated into the drift space. It arrives back at the grids at time t_n. An electron (b) leaving at time t_2 receives no acceleration because the RF signal is now at zero volts. Thus electron (b) does not travel as far into the drift space and arrives back at the grids at the same time as electron (a). Electron (c) leaving at time t_3 is decelerated since the RF signal has reversed voltage polarity since time t_1.

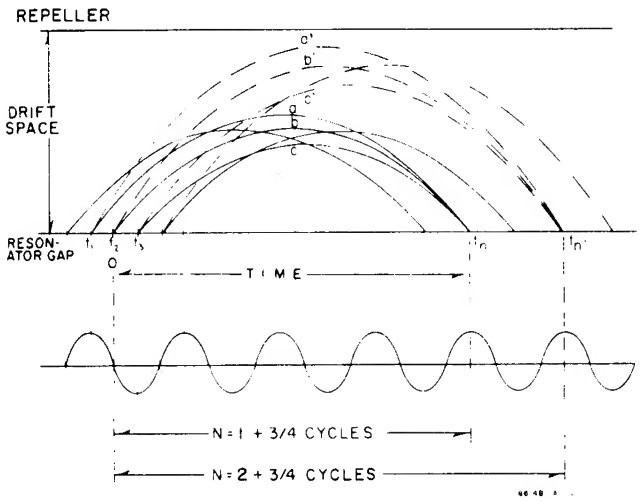


Figure 4-5. Bunching of Electrons

Electron (c) travels a shorter distance into the drift space and arrives back at the grids at the same time as electrons (a) and (b).

4-18. When bunched electrons arrive back at the grids at a time when the RF signal tends to retard their return, they deliver energy to the grids and sustain oscillations in the resonant cavity.

4-19. The time that the electrons spend in the drift space is adjusted by changing the repeller voltage. As repeller voltage is increased in the negative direction, electrons a, b, and c spend less time in the drift space. As repeller voltage is decreased electrons a^1, b^1, and c^1 (Figure 4-5) travel farther into the drift space and take a longer time (t_n1) to return to the grids. At the low end of the instrument frequency band (up to about mid-frequency), the repeller voltage is adjusted so that the number of oscillations (N) that occur at the grid while the electrons are in the drift space is equal to 1-3/4 cycles. At the high end of the frequency band (above about mid-frequency), the repeller voltage is adjusted so that the number of oscillations equals 2-3/4 cycles. When the oscillator is operating with 1-3/4 cycles drift time it is known as operating in the 1-3/4 repeller mode.

4-20. RF OSCILLATOR TUBE.

4-21. The RF oscillator tube is a reflex klystron operating in a tunable cavity resonator. The klystron and cavity assembly is shown in Figure 5-5. The klystron cavity system operates on the 3/4 wavelength cavity mode, and oscillation on both the 1-3/4 and 2-3/4 repeller modes are employed to cover the frequency range of the instrument. The 1-3/4 mode is used from low frequency up to about mid-frequency. At about mid-frequency the tuning mechanism actuates mode switch S202 to decrease the voltage applied to the repeller by about 160 volts (200 volts for the 8616B). This action places the system on the 2-3/4 mode for the remainder of the band from approximately 1.6 Gc to 2.4 Gc (3.0 Gc to 4.5 Gc for the 8616B).

4-23. Voltage is applied to the klystron repeller from variable resistor R220. The movable arm of R220 is ganged to the frequency drive in such a manner that voltage on the repeller is automatically tracked with frequency in the desired repeller mode.

4-23. REGULATED POWER SUPPLY.

4-24. The regulated power supply includes two power supplies: the high-voltage supply, and the filament supply. The supplies are conventional series-regulated types. The series regulator is connected in series with the main load. The output voltage is monitored and compared to a reference voltage. The voltage differential between the monitored and reference voltage is applied through a control amplifier to the series resulator. This differential voltage changes the effective resistance of the series regulator which in turn holds the output voltage constant (see Figure 4-6).

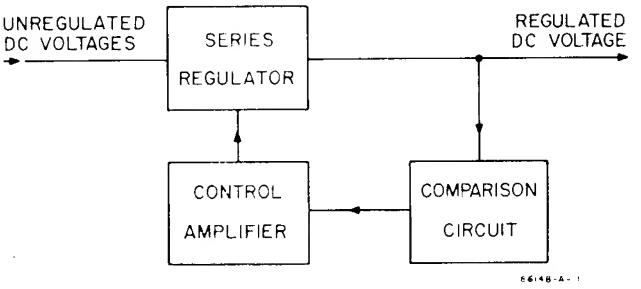


Figure 4-6. Series-Regulated Power Supply

4-25. The high-voltage supply consists of two supplies which have been combined to obtain required voltages. They are a -320 volt supply on which a -350 volt supply has been stacked to provide a total of -670 volts (-720 volts for 8616B). Both supplies use voltage doublers to drive series regulator circuits. Since this is a combined circuit arrangement, both supplies are interdependent. There is also a gas regulator tube, V105, connected to the -320 volt supply to provide a -212 volt regulated source.

4-26. The low-voltage supply provides 6.1 volts DC for filament operation. The filament supply uses a half-wave rectifier and a series regulator.

Table 5-1. Test Equipment Required

Instrument Type	Check	Critical Specifications	Recommended Instrument
Oscilloscope	Calibration Troubleshooting Performance	Range: 30 to 0.5 μs/cm Sensitivity: 0.005 to 1.0 v/cm Accuracy: ±3%	℗ Model 175A or ℗ Model 140A
Crystal Detector	Calibration Troubleshooting Performance	Frequency Range: 800 to 4500 Mc Sensitivity: 100 mv/0.35 mw Frequency Response: ±0.5 db	℗ Model 423A
Power Meter	Calibration Performance	Power Range: 0.1 to 10 mw Frequency Range: 800 to 4500 Mc Accuracy: ±3%	℗ Model 431B Power Meter with ℗ Model 478A Thermistor Mount
DC Voltmeter	Calibration Troubleshooting	Range: 1 to 725 volts Accuracy: ±0.2% of reading Floating Input: May operate within ±470 vdc of chassis ground	℗ Model 405B/BR or ℗ Model 3440A Digital DC Voltmeter
AC Voltmeter	Calibration Troubleshooting	Range: 0 to 20 mv Accuracy: ±2% of reading Floating Input: May operate within ±470 vdc of chassis ground	℗ Model 403B
Clip-On Milliammeter	Calibration	Range: 0 to 35 ma Accuracy: 3% ±0.1 ma	℗ Model 428A
Ohmmeter	Troubleshooting	Range: 1 to 100 megohms Accuracy: ±5% of full scale	℗ Model 412A
Calibrated Frequency Meter	Calibration Performance	Range: 8614B - 800 to 2400 Mc 8616B - 1800 to 4500 Mc Accuracy: 0.06% - 8616B 0.03% - 8614B	℗ Model 536A (1000 to 4100 Mc) PRD 587A (800 to 1000 Mc) ℗ Model G532A with G281A (2) (4000 to 4500 Mc)
Pulse Generator	Calibration Performance	Pulse Rep Rate: 50 to 5000 pps Output: 27 volts peak	℗ Model 212A
Soldering Iron and Tips	Troubleshooting Repair	Wattage Rating: 50 watts Min Tip Temp: 800°F Tip Size: 1/16" to 3/32" Round Tip Diameter: 3/4"	Ungar #665 Handle Ungar #885 3/4" Cup Tip Ungar #PL333 Tiplet
FM Modulator	Frequency tracking, preliminary	Outputs: 300 volts peak-to-peak and 6.3 vac Input: 115 vac, 60 cycle Phase Adjustable: Approx 80°	Power Transformer (1) (9100-0045) Capacitors (2) (0140-0003) Potentiometers (2) (2100-0047) Fuseholder, extractor post type (1) (1400-0084) Power Cord (1) (8120-0050) Fuse lamp, 115V (1) (2110-0007)
DC Power Supply	Troubleshooting Power Supply	Output: 315 to 353 vdc Ripple: Less than 3 mv	℗ Model 711A

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance and service information for the Signal Source. The section includes recommended test equipment, replacement procedures, repair and adjustment procedures, and troubleshooting charts. Also included are performance checks which verify proper instrument operation.

5-3. CLEANING THE AIR FILTER.

5-4. Inspect the air filter regularly and clean it before it becomes dirty enough to restrict air flow. To remove and clean the air filter, proceed as follows:

a. Remove filter from instrument rear panel by removing the four machine screws at the corners.

b. Wash filter in warm water and detergent.

c. Dry filter thoroughly and remount on instrument.

5-5. TEST EQUIPMENT.

5-6. Table 5-1 lists test equipment required for use in maintaining and checking instrument performance. Equipment having similar characteristics can be substituted for the equipment listed.

5-7. TROUBLESHOOTING.

5-8. LOCATING TROUBLE.

5-9. Always start locating trouble with a thorough visual inspection for burned-out or loose components, loose connections, or any condition which suggests a source of trouble. Check tubes for open filaments by touching tubes and replace all that are cold (except V105 and V202 which are cold cathode tubes). Replacing a cold tube, in most cases, will restore the generator to normal operation. Check the fuse to see that it is not open.

5-10. If trouble cannot be isolated to a bad component by a visual inspection or a cold tube, the trouble should then be isolated to a circuit section. Isolation to a circuit section can best be accomplished by using the block diagram, Figure 5-1.

5-11. TROUBLESHOOTING CHARTS.

5-12. Troubleshooting charts, Tables 5-2 and 5-3, list checks and symptoms, possible causes, and remedies of various troubles. The power supply be checked first; refer to Paragraph 5-14.

5-13. For simplification, only major components are referenced in the troubleshooting charts, but it should be remembered that associated components are also failure possibilities. When testing the signal source it is recommended that line voltage be applied through a variable transformer, and that the transformer be adjusted to deliver a voltage at the low end of the rated

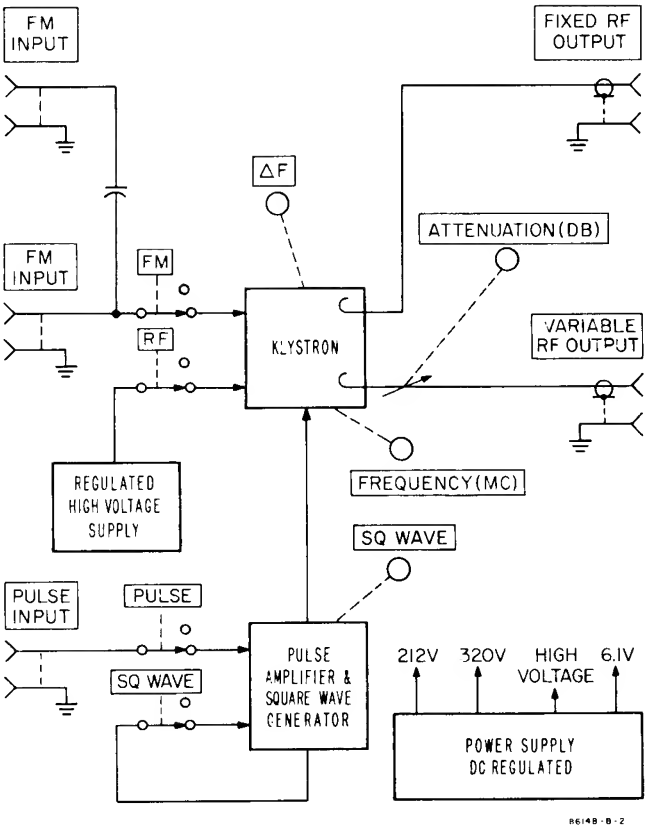


Figure 5-1. Block Diagram

103- to 127-volt range. An instrument in good condition should operate satisfactorily from any line voltage within the rated range, but where there is marginal operation (from weak tubes, etc), weaknesses become easier to trace at low line voltages.

5-14. POWER SUPPLY.

5-15. Correct operation of the power supply is vital to proper operation of the signal source. Noise or variation in the regulated voltages causes other circuits to operate in a random or erratic manner. It is advisable to make a voltage check of the power supply whenever the instrument is suspected of marginal operation. This eliminates factors such as low voltages or poor regulation which cause unsatisfactory performance in other sections of the instrument.

5-16. The power supply consists of two interdependent series-regulated voltage supplies, furnishing -320 and -670 volts (-720 volts for 8616B) as measured from chassis ground and a regulated filament supply furnishing -6.15 volts.

a. The -320 volt regulated supply furnishes voltage to the klystron cathode and modulation circuit. It also

Table 5-2. Power Supply Troubleshooting

Symptom	Conclusion	Remedy
-350 VOLT SUPPLY (-400 for 8616B)		
Connect Voltmeter common to test point 3 and positive lead to test point 4 (see Figure 5-3).		
-350 ±2 VDC; 4 mv AC (-400 ±2 VDC - 8616B)	Supply OK	
Small deviation	Out of adjustment	Adjust R212 (see Figure 5-2)
Large or erratic deviation	-350 volt (-400 or -320 volt supply bad Note See Figure 5-4 for component location	Remove V101 and V102 and connect a -320 volt DC power supply between test points 5 and 3. Recheck supply. If deviation still exists check V201, V202, V203, V204, C201, C202, CR201, or CR202.
-320 VOLT SUPPLY		
Connect Voltmeter common to test point 3 and positive lead to test point 5 (see Figure 5-3).		
+320 ±5 VDC; 7 mv AC	Supply OK	
Small deviation	-350 volt (-400) supply out of adjustment	Check and adjust -350 volt supply
Large or erratic deviation	-320 volt or -350 volt (-400) supply bad Note See Figure 5-4 for component location	Remove V201 and connect a -350 volt DC power supply between test points 3 and 4. Recheck supply. If deviation still exists check V101, V102, V103, V104, C101, C102, CR101, or CR102.
-212 VOLT SUPPLY		
Connect Voltmeter common to test point 3 and positive lead to test point 6 (see Figure 5-3).		
+108 ±5 VDC	Supply OK	
Voltage unstable	Defective V105 Defective -320 volt regulation	Check V105 Check -320 volt supply
FILAMENT SUPPLY		
Connect Voltmeter between test points 1 and 2 (see Figure 5-4).		
-6.15 ±0.1 VDC; 25 mv AC	Supply OK	
Small deviation	Out of adjustment	Adjust R5 (see Figure 5-2)
Large or erratic deviation	-320 volt reference or or filament regulation defective	Check -320 volt supply Check Q1, Q2, CR1, or CR4

furnishes a regulated -212 volts for the modulation circuit. This voltage is taken from an additional voltage regulator tube (V105), included between the -320 volt supply and chassis ground.

b. The -350 volt regulated supply (-400 volt for 8616B), stacked with the -320 volt supply furnishes -670 volts (-720 volts for 8616B) to the klystron repeller and modulation circuit.

5-17. The two high-voltage regulated supplies are stacked, and each supply references the other. To troubleshoot either supply, always remove series regulator and replace the other supply with an external DC power supply.

5-18. To measure and adjust power supply voltages, the following procedures should be followed. This permits the voltmeter common for all high-voltage measurements to be attached to a common point while the DC probe is moved from point to point.

WARNING

When using a metal case VTVM with common connected to chassis ground, the metal case will be at common lead potential.

a. Remove four #6-32 screws from top cover and remove top cover (also remove bottom cover).

b. Open out hinged power-supply board by removing two screws that secure board.

Table 5-3. General Trouble Location

Symptom (outputs)	Trouble Location	Check
No RF	High Voltage Power Supply	Measure supply voltages (see Table 5-2)
	Filament Supply	Measure supply voltage (see Table 5-2)
	RF Probes	Turn instrument off and measure resistance at each RF Output connector; should be about 52 to 58 ohms (Paragraph 5-43)
	Modulation Circuit (a) PULSE. . . not depressed (b) SQ WAVE . not depressed	Measure DC voltage at test point 11 on circuit board; should be about -306 to -310 vdc (Paragraph 4-6) (see Figure 5-4)
	Klystron	V1
Continuous wave but no pulse or Sq Wave	Modulation Circuit	Depress PULSE with no pulse input and measure test point voltages
	(a) Test Point 7: about -220V (b) Test Point 8: about -46V (c) Test Point 9: about -325V (d) Test Point 10: about -333V (e) Test Point 11: about -327V	V401A OK V401B OK CR402 OK CR401 OK CR404, CR406, Q401, Q402 OK
Continuous wave and sq wave OK but not pulse	Broken ground connection	Check chassis ground connections at board numbers 17 and 9 (see Figure 5-4)
	Modulation Circuit	Test points and power supply voltages

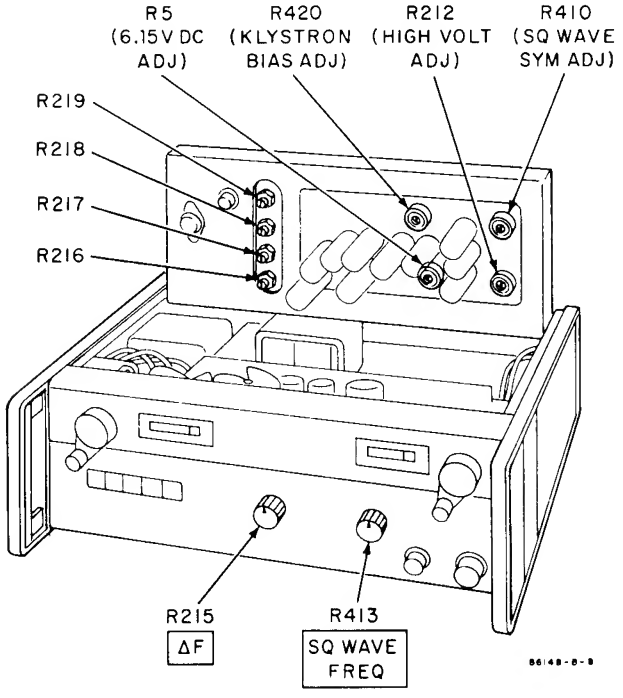


Figure 5-2. Electrical Adjustment Location

c. Set AC voltage at 115 or 230 volts AC as appropriate and depress LINE button.

d. Connect HP Model 405DC Voltmeter and HP Model 403B VTVM in parallel (see Table 5-2).

CAUTION

Voltmeter leads should not touch chassis ground unless specified.

e. Regulated voltages may vary ±1 volt (high voltages) and ±0.2 volt (filament supply) due to 10% variation in line voltage.

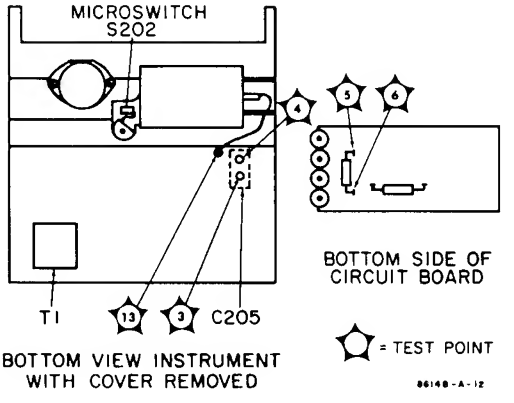


Figure 5-3. High Voltage Test Point Location

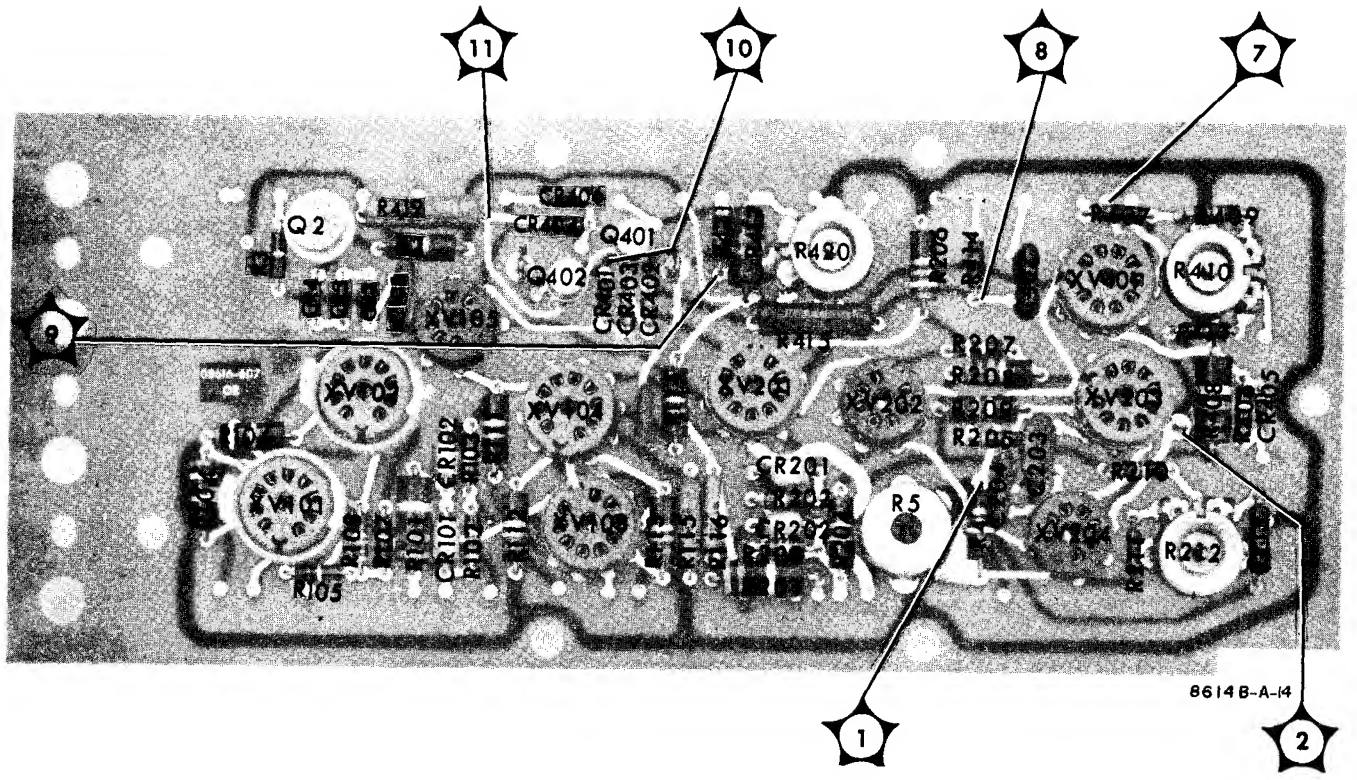


Figure 5-4. High Voltage Board (A100)

5-19. REPAIR.

5-20. COVER REMOVAL.

5-21. To remove top or bottom cover proceed as follows:

a. Remove four #6-32 flathead screws from cover.

b. Slide cover back and off instrument.

5-22. SERVICING ETCHED CIRCUIT BOARD.

5-23. The etched circuit board is a plated-through type consisting of a base board and conductor but, not funneled eyelets. The conductor material is plated to the wall of the holes thus the holes are effectively extended through the board. This type of board can be soldered from either side of the board as detailed below.

a. Do not apply excessive heat.

b. Remove a damaged component by clipping leads near component.

c. Apply heat to component lead and remove lead with a straight upward pull. Use a special soldering iron tip to remove components having multiple connections, such as potentiometers, transformers, etc. Refer to Table 5-1 for type of soldering tip required.

d. Use a toothpick to free hole of solder before installing a new component.

5-24. KLYSTRON REMOVAL & REPLACEMENT.

5-25. TUBE REMOVAL.

WARNING

Be certain that line power is removed from instrument.

a. Remove panel cover on left (with respect to front panel) side of instrument.

b. Set klystron frequency drive at top end (2400 Mc for 8614B or 4500 Mc for 8616B).

c. Using truarc pliers which are available in a repair kit, hp Stock No. 08614-800, remove outer truarc ring from outer cover of klystron cavity (see Fig. 5-5).

d. Remove outer cover. Remove inner truarc ring holding klystron clamp housing in klystron cavity.

e. Remove tube socket from klystron with a straight pull. Remove klystron tube from cavity. Unscrew clamp nut, lift out clamp spacer, and remove klystron (see Figure 5-5).

f. Remove waffle washer from cavity. Note: see Paragraph 1-12 for warranty claim instructions.

5-26. TUBE REPLACEMENT.

a. Reassemble new klystron, housing, spacer, and nut.

b. Set klystron frequency drive at top end (high frequency dial setting) for klystron centering.

c. Place waffle washer in klystron cavity.

d. Insert klystron straight into cavity. The klystron should fit snugly but easily, into cavity.

e. Replace inner truarc ring on clamp housing (if klystron is properly in place, ring will fit properly). Allow tube to be centered by center conductor.

f. Install tube socket and outer cover.

g. Place edge of truarc ring on outer cover and rotate until ring lies flat on cover and is easily accessible with truarc pliers.

h. Refer to Adjustments (Paragraph 5-34) and make necessary adjustments.

5-27. RF PROBE REMOVAL & REPLACEMENT.

5-28. PROBE ASSEMBLY REMOVAL.

WARNING

BEFORE ATTEMPTING PROBE ASSEMBLY REMOVAL OR REPLACEMENT, BE CERTAIN THAT LINE POWER IS COMPLETELY REMOVED FROM INSTRUMENT.

a. Set klystron drive at top end (high frequency dial setting).

b. Remove top cover and attenuator access cover (see Figure 5-8).

c. Remove frame assembly cover on right (with respect to front panel) side of instrument.

d. Remove cable guide from klystron cavity casting and detach cable assembly connector from instrument (see Figures 5-6 and 5-8).

e. Remove retaining screw from defective probe in klystron cavity casting and remove from casting (see Figure 5-8).

f. Remove cable assembly connector from R F probe cable assembly. Be careful not to lose any parts removed from probe cable assembly as they will be required for reassembly.

g. The defective probe assembly should be returned to your local Hewlett-Packard field office for repair or replacement.

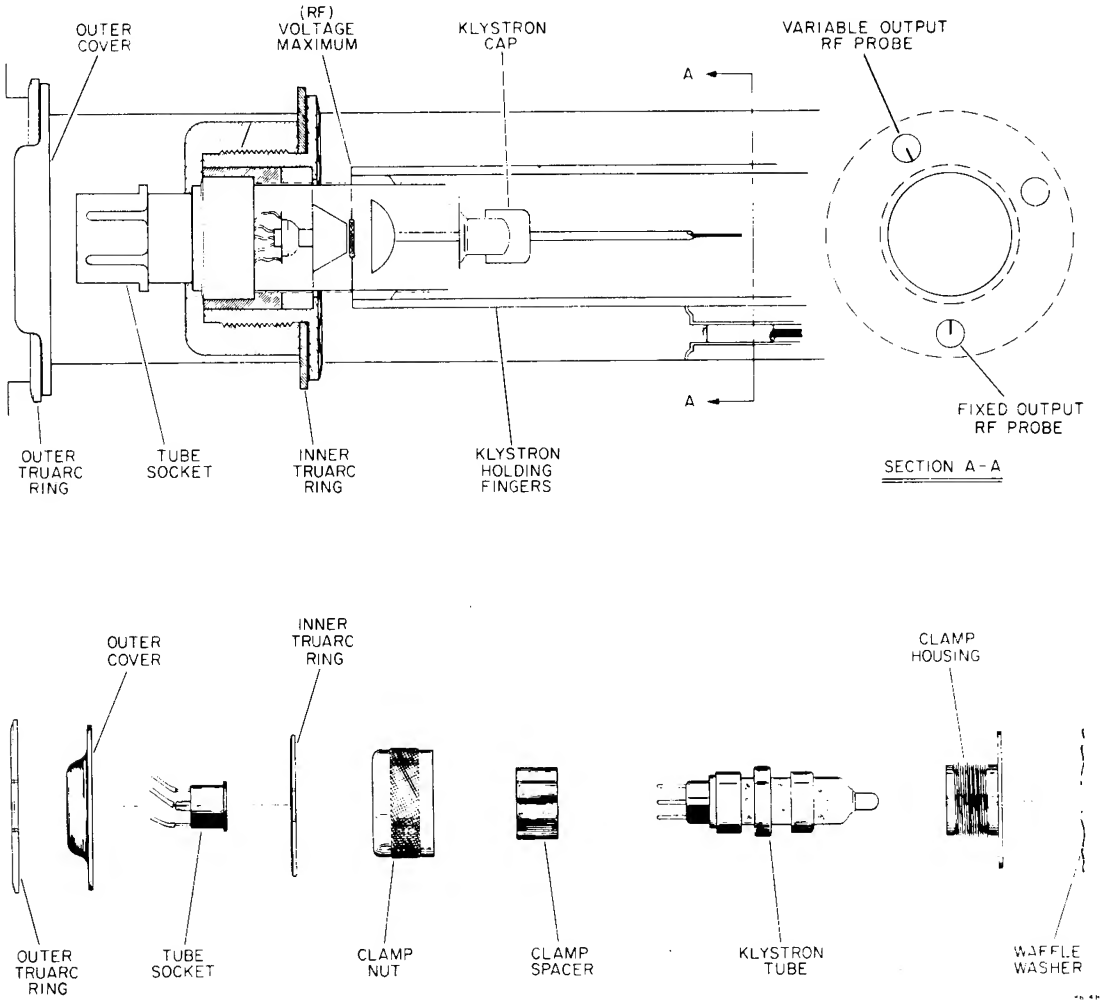


Figure 5-5. Klystron Assembly in Cavity

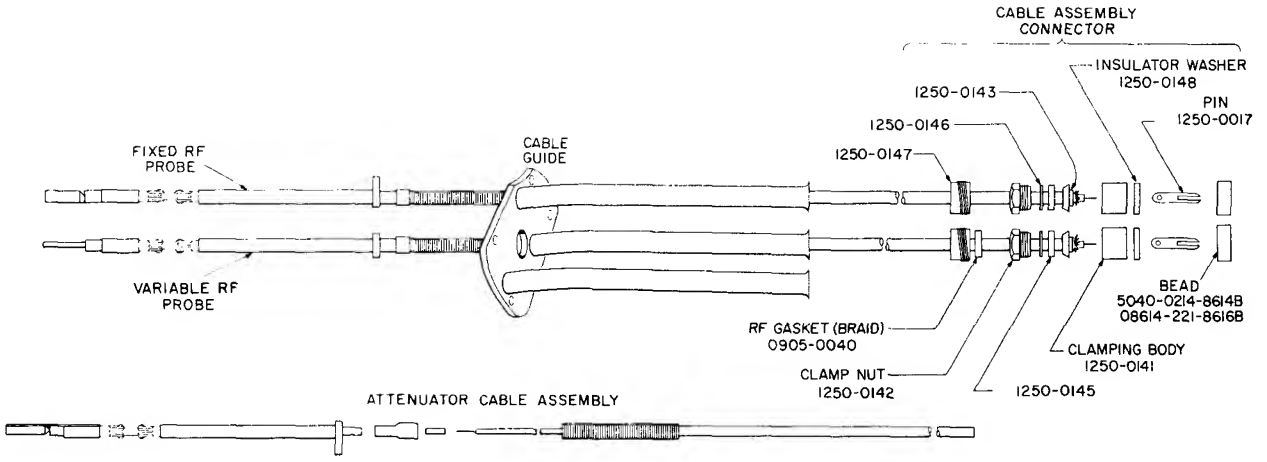


Figure 5-6. RF Probe Assembly

CAUTION

THE PROBE IS FRAGILE AND SHOULD BE HANDLED WITH CARE. FOR SHIPPING AND HANDLING PURPOSES THE PROBE SHOULD BE PLACED IN A PROTECTIVE SLEEVE.

5-29. PROBE ASSEMBLY REPLACEMENT.

a. The probe assembly cable must be inserted through the cable guide (see Figure 5-6).

b. Trim insulation from end of probe assembly cable (about 5/16 inch).

c. Place cable assembly connector parts on cable with the exception of clamping body, and fold braid back upon connector assembly.

d. Place clamping body on cable and screw clamp nut and clamping body together.

e. Trim dielectric flush with end of clamping body so that center conductor is bare.

f. Tin center conductor protruding from clamping body, then place insulator washer on center conductor. Note: After tinning center conductor, diameter may be too large making it necessary to file center conductor to proper diameter.

g. Replace connector assembly as it was before disassembly. Refer to Power Adjustment (Paragraph 5-43) and make necessary check and adjustment.

5-30. CAM CABLE REPLACEMENT.

5-31. TOOLS REQUIRED.

a. Open-end wrench (3/8-inch).

b. Hex-socket wrench and 3/8-inch socket or equivalent tool.

c. Book of matches.

d. Roll of masking tape (1/2-inch or 1-inch width).

e. Rubber cement.

5-32. PROCEDURE.

5-33. If it is necessary to replace cam cable, order it by hp Stock No. 08614-299 and description of usage. For easier access to the cams, remove the screws holding the High Voltage circuit board and swing the board out of the way. Use Figures 5-7 and 5-8 as a guide and proceed as follows:

a. Remove power cord from instrument.

b. Remove instrument top cover and attenuator access cover.

c. Turn FREQUENCY (MC) to approximately the middle of the frequency band.

d. Orient Length Cam to Frequency Cam as shown in Figure 5-8.

e. Using a lead pencil, mark position of each cam and end of threaded portion of center conductor support rod on klystron cavity casing.

f. Using hex socket wrench and a 3/8-inch open-end wrench, remove both terminal screws, the four washers, and the two nuts (10-32 x 0.375 hex nuts).

g. Remove both terminal screws from cable.

h. On replacement cable, place a mark halfway between each end. Using matches apply heat to an area

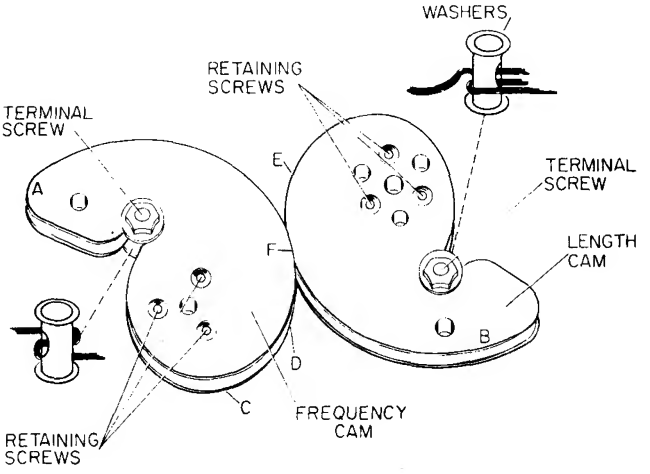


Figure 5-7. Cam Assembly

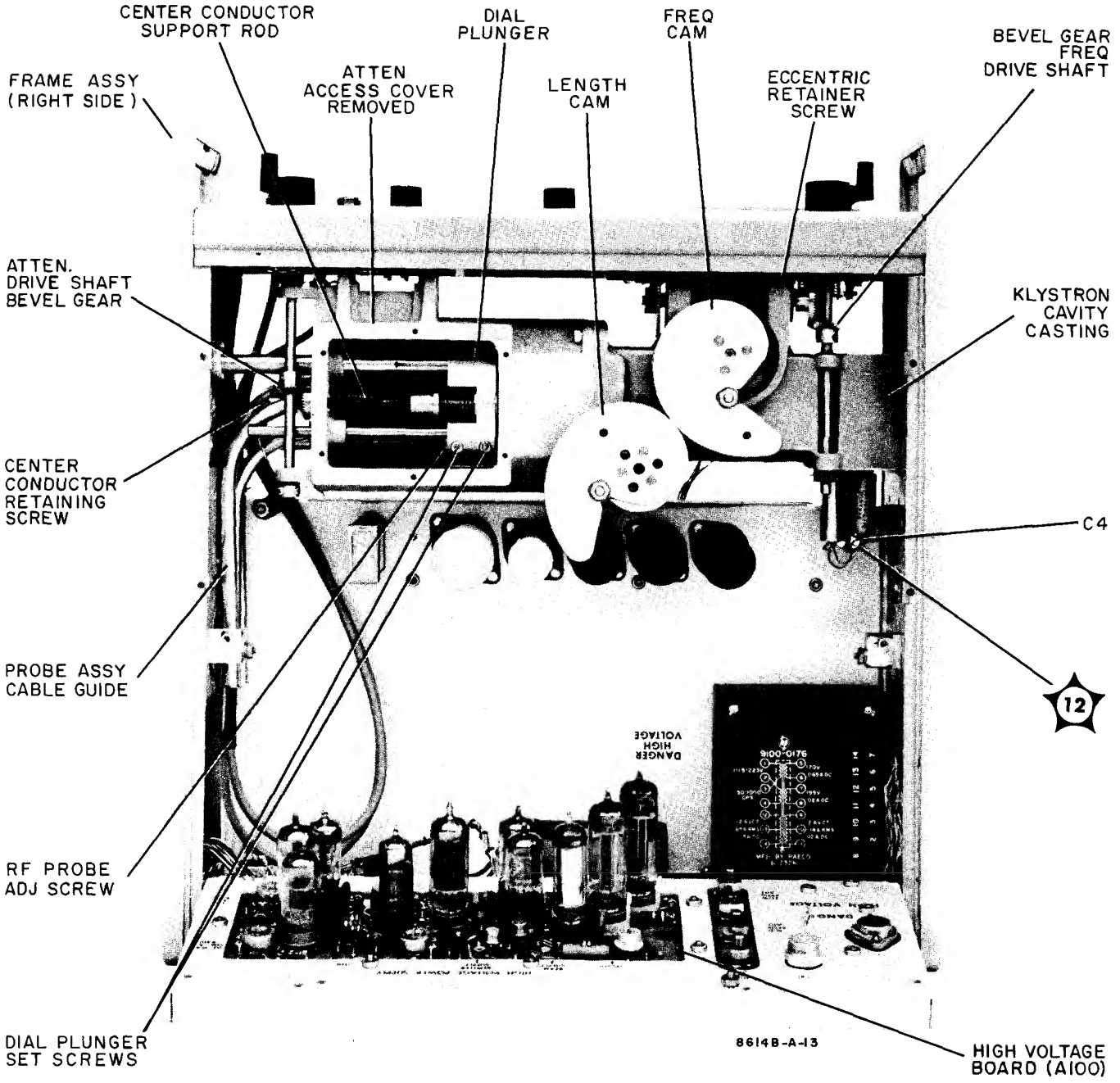


Figure 5-8. Model 8614B Top View, Cover Removed

approximately 1/2 to 3/4 inch on either side of mark to remove wire tension (heat to nearly white hotness).

i. Cut 10 or 11 strips of masking tape approximately one inch in length.

j. Remove three retaining screws from Frequency Cam and remove cam from instrument (Note: three retaining screws are 4-40 x 0.625 FH).

k. Slide cable through one terminal screw so that cable is oriented to terminal screw as shown in Figure 5-7 for the Frequency Cam, and install terminal screws on Frequency Cam.

CAUTION

Be careful not to catch cable between lockwasher and cam.

m. Slide cable onto cam just pass point A and tape to cam (half of cable length should pass over points A and B; the other half should pass over points C, D, and E).

Note

Each cam as shown in Figure 5-7 has two lips along which the cable should travel: one cable must travel along the upper lip of both cams and one cable must travel along the lower lip of both cams.

n. Slide other half portion of cable onto cam just past point D and tape to cam.

p. Place Frequency Cam in original position in instrument and replace retaining screws.

q. Turn Length Cam so that cams are not touching at point F and place cable between cams: one cable along upper lip of cam and the other along lower lip of cam.

r. Turn Length Cam so it is apparently touching Frequency Cam at point F and place two pieces of masking tape across the two cams at point F.

s. With cams held together, slide cable which passes over points C and D past point E and cable which passes over point A past point B and tape each portion of cable to cam.

Note

It is important that each cable portion have as little slack between it and the cams as possible: a loose cable causes backlash.

t. Slide cable ends through second terminal screw so that cable is oriented to terminal screw as shown in Figure 5-7 for the Length Cam.

u. Install second terminal screw on Length Cam and tighten both terminal screws to remove all slack in cable.

v. Remove masking tape from cams and apply rubber cement to ends of cable to ensure that cable will not unravel.

w. Turn FREQUENCY (MC) knob to match Frequency Cam to pencil mark made in step e; the other marks made should match appropriately.

x. Perform Frequency Range Spread Adjustment, Paragraph 5-40.

5-34. ADJUSTMENTS.

5-35. ADJUSTMENTS FOLLOWING KLYSTRON REPLACEMENT.

5-36. Following replacement of a new klystron, certain adjustments must be made before the instrument will operate in a satisfactory manner. The general steps in the overall procedure are as follows:

a. Establish initial repeller tracking voltages.

b. Establish proper beam current and klystron bias.

c. Establish proper repeller mode operation.

d. Adjust frequency range spread.

e. Adjust pulse modulation.

f. Adjust square-wave modulation.

g. Adjust power output.

5-37. INITIAL REPELLER-VOLTAGE ADJUST.

a. Remove top and bottom covers (refer to Paragraph 5-20) and remove two screws that secure circuit board.

b. Check all power supply voltages as indicated in Table 5-2.

c. Connect DC Digital Voltmeter between klystron repeller (test point 13 and chassis ground, see Figure 5-3). Make sure ΔF control on front panel is set at zero (center position), and set voltages as indicated in Table 5-4 (see Figure 5-2).

WARNING

Be careful not to ground test point 13 as power supply will be destroyed.

Table 5-4. Klystron Repeller Voltages

Frequency Dial (8614B (8616B)	Adjust	Voltage (between klystron repeller and ground)	
		8614B	8616B
800 (1800)	R216	-370 ±5V	-440 ±5V
Mid-frequency			
below switch	R217	-600 ±5V	-660 ±5V
above switch	R218	-425 ±5V	-460 ±5V
2400 (4500)	R219	-580 ±5V	-640 ±5V
Note: R216 and R217 interact as do R218 and R219; therefore, repeat above measurements after any adjustments.			

5-38. BEAM CURRENT AND KLYSTRON BIAS ADJUST.

a. Connect a Clip-On Milliammeter, such as HP Model 428A, to wire on center feed-through capacitor, C4 (wht/orn/vio wire, see Figure 5-8).

b. Connect crystal detector/oscilloscope combination to VARIABLE RF OUTPUT and set FREQUENCY (MC) to 1650 MC (3050 MC for 8616B).

c. Depress RF button and adjust klystron bias adjust, R420 increasing beam current (as measured on Clip-On Milliammeter) and VARIABLE RF OUTPUT (as measured on detector/oscilloscope combination) until clamping occurs: clamping occurs when increased rotation of R420 no longer causes a current or RF output increase. Note: beam current should not exceed 28 ma (see Figure 5-2).

d. If beam current exceeds 28 ma or VARIABLE RF OUTPUT begins to decrease, adjust R420 until beam current is equal to or less than 28 ma and VARIABLE RF OUTPUT is slightly less than maximum.

e. Adjust Mid-Freq adjustment, R218, for a maximum VARIABLE RF OUTPUT and repeat steps c and d above.

f. If clamping action referred to in step c occurs before VARIABLE RF OUTPUT begins to decrease and before beam current exceeds 28 ma, go to next procedure. If clamping action does not occur before VARIABLE RF OUTPUT begins to decrease or before beam current exceeds 28 ma, readjust R420 as in step d above. Using a DC Voltmeter, such as the hp Model 405B with a floating input, measure voltage difference between klystron cathode and control grid (see Figure 5-8). Replace CR404 with a zener diode whose breakdown voltage is as close to, but slightly less than, the measured voltage minus 0.6 volts (see Figure 5-4).

g. If CR404 was replaced, repeat adjustment procedure from Paragraph 5-37.

5-39. REPELLER MODE ADJUST.

a. At a dial frequency of 950 Mc (1800 Mc - 8616B) set attenuator dial for a calibrated output of about 0 dbm.

b. To observe repeller modes of the klystron, a FM Modulator, with adjustable phase and amplitude controls, is necessary. Such a device is shown in Figure 5-9; it consists of a small power transformer connected with the primary and secondary windings interchanged; two one-megohm potentiometers; a 0.01 μf capacitor; two BNC connectors; a fuseholder, and a power cord. Connected as shown, this modulator provides a power line frequency modulation voltage continuously variable in amplitude from 300 volts peak-to-peak, with phase variable over a range of approximately 80 degrees, plus a 6.3-volt AC output for oscilloscope sweep control (see Table 5-1).

c. Apply external FM (60 cycles) and view mode patterns on oscilloscope. Adjust PHASE control of FM modulator and appropriate tracking pot for mode patterns shown (all 8616B patterns should appear as 2400 Mc/s pattern for 8614B).

Note

DC repeller voltages (8614B) at 950 Mc and 1600 Mc (above switch) are relatively small and will not appear correctly if FM signal is excessive.

(1) Adjustments should allow about 2-Mc variation with ΔF control.

(2) The tracking pots interact making it necessary to repeat the adjustments a time or two in order to insure proper tracking.

d. Measure klystron beam current: using a Clip-On Milliammeter connected to wire on center feedthrough capacitor C4, current must not exceed 28 ma. Note: If current exceeds 28 ma, refer to Paragraph 5-38.

5-40. FREQUENCY RANGE SPREAD ADJUST.

a. Using a calibrated Frequency Meter, measure actual frequency at dial settings of 1000 and 2400 Mc (1800 and 4000 Mc for 8616B). To eliminate backlash error, always approach frequency dial settings from the same direction.

b. The difference in the frequency measurements of step a should be 1400 Mc for the 8614B and 2200 Mc for the 8616B. If frequency difference is other than specified, correction must be made (see step c).

c. Refer to graph, Figure 5-10. The horizontal axis represents the measured frequency change from step b, the vertical axis indicates the dial corrective setting. For example, if the difference between dial settings (step b) is 1354 Mc, the corrective setting for the dial as found on the graph is 990 Mc. To make correction, set frequency dial to 1000 Mc, loosen the two setscrews that clamp dial plunger to rack, hold dial plunger stationary, and set dial to 990 Mc. Tighten two setscrews (see Figure 5-8).

d. If any adjustment was necessary, repeat steps a, b, and c. Repeat this procedure until measured frequency difference corresponds to a change of 1400 Mc ±3 Mc for the 8614B and 2200 Mc ±6 Mc for the 8616B.

e. Set actual frequency to 1000 Mc (1800 Mc for 8616B). Loosen spur gear on worm shaft and rotate gear until frequency dial reads 1000 Mc (1800 Mc).

f. Check FREQUENCY (MC) dial settings at both upper and lower ends of dial travel. The respective dial end points should be less than 800 Mc (1800 Mc for 8616B) and greater than 2400 Mc (4500 Mc for 8616B). If dial travel is not satisfactory, loosen bevel gear on frequency drive shaft and reset dial.

g. Check microswitch action: microswitch should energize and de-energize at about 1590 to 1610 Mc (2988 to 3012 Mc for 8616B). If microswitch does not switch at proper dial settings, microswitch cam (located on underside of cavity casting) should be repositioned (see Figure 5-3).

h. Being careful to approach all dial settings from the same (either clockwise or counterclockwise) direction, using the procedure given in Paragraph 5-46, check accuracy of frequency dial by approaching all dial settings from a clockwise direction and then from a counterclockwise direction.

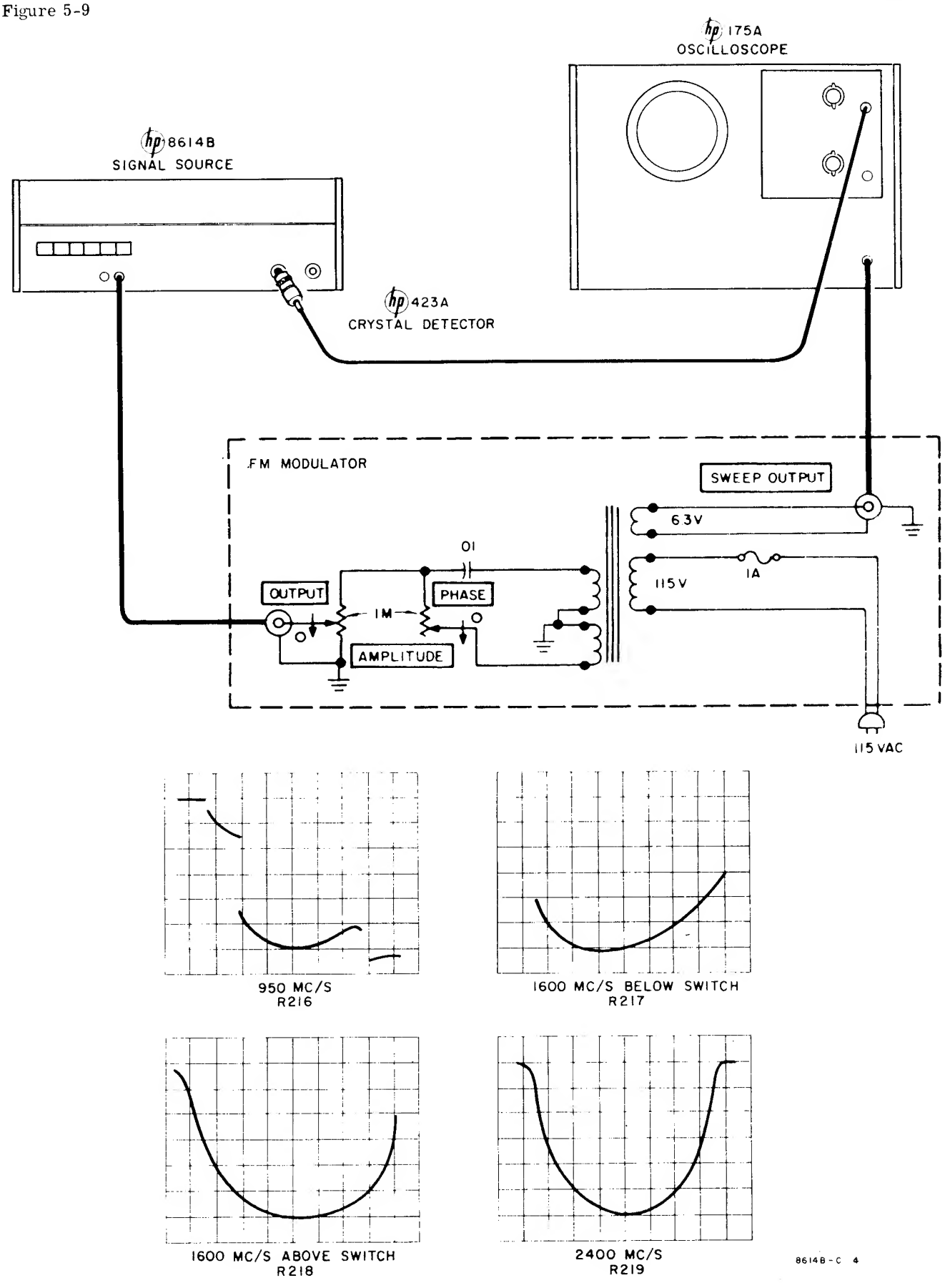


Figure 5-9. Repeller Mode Adjust

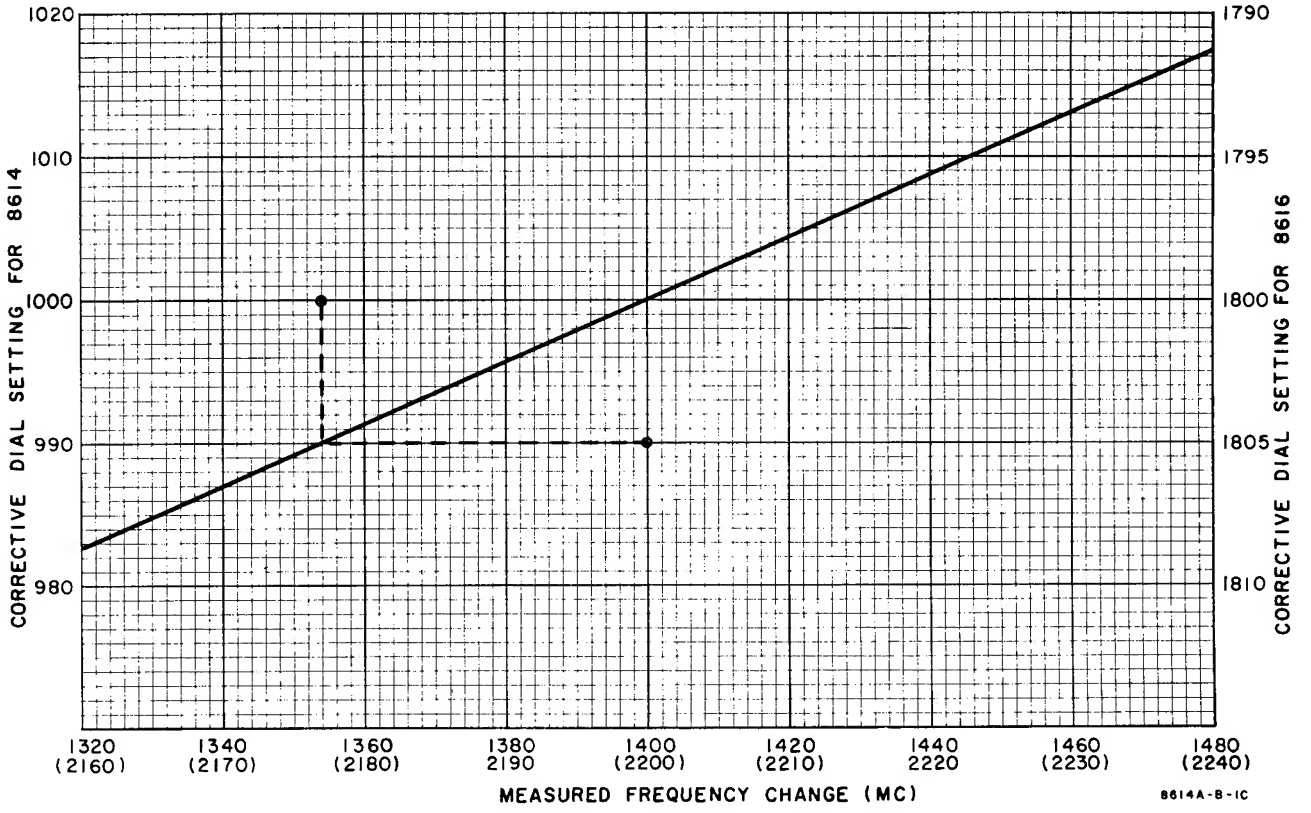


Figure 5-10. Frequency Range Spread Correction

Note

The Frequency Meter used must be calibrated to an accuracy of approximately ±0.03% (±0.07% for 8616B).

i. If frequency dial reading errors are greater than ±5 Mc (±10 Mc for 8616B), shifting the dial may bring all errors within specification. If shifting dial will not sufficiently correct errors, it may be necessary to shift position of center conductor support rod (see Figure 5-8). The center conductor is notched at end closest to right side of instrument and may be loosened and then adjusted "in" or "out" of klystron cavity. Notch or scratch center conductor rod so that original position may always be known. If overall frequency error was positive, adjust center conductor toward right side of instrument. If overall error was negative, adjust center conductor toward left side of instrument. When adjusting center conductor position, never change by more than about 20 thousandths of an inch at a time.

Note

If any adjustment of instrument was necessary, repeat entire check and adjustment procedure until no adjustment is required.

5-41. PULSE MODULATION ADJUST.

a. Connect instruments as shown in Figure 5-11.

b. Set up as follows:

LINE	depressed
RF	depressed
EXTERNAL PULSE	not depressed

c. Set up Pulse Generator for a +25 volt ±1 volt, 5000-prf signal with a pulse width of 2.0 ±0.5 μsec.

d. Set up Oscilloscope for a 0.005 volt/cm, vertical sensitivity, EXT AC synchronization, and a 0.5 μsec/cm sweep rate.

Note: Oscilloscope vertical input should be shunted with between 50 and 300 ohms for best pulse presentation.

e. Depress PULSE button to be sure that +25 volt input will pulse klystron. Be sure ΔF control is centered.

f. Check pulse operation across the band and adjust klystron repeller voltages (using R216 through R219) as necessary. Specification: Rise time ≤ 0.3 μsec; decay time ≤ 0.5 μsec; overshoot ≤ 5%; jitter ≤ 0.4 μsec.

g. If any adjustment of potentiometers R216 through R219 was necessary, repeat procedures detailed in Paragraphs 5-39, 5-40, and 5-41.

5-42. SQUARE-WAVE MODULATION ADJUST.

a. Connect instruments as shown in Figure 5-12.

b. Set up Signal Source as follows:

LINE	depressed
RF	depressed
INT SQ WAVE	depressed
ATTENUATION (DB)	0 DB
SQ WAVE FREQ	full counterclockwise

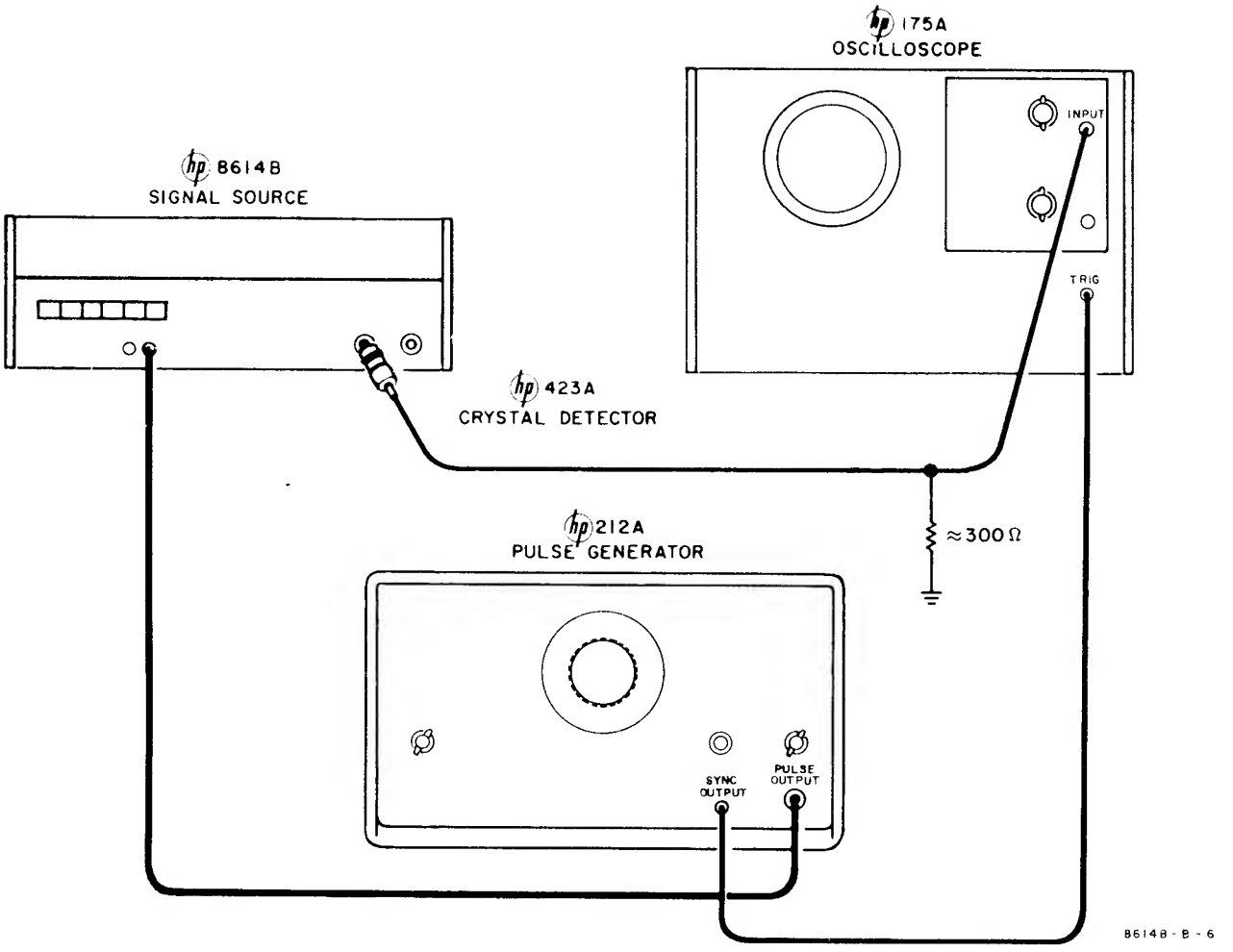


Figure 5-11. Pulse Modulation Adjust

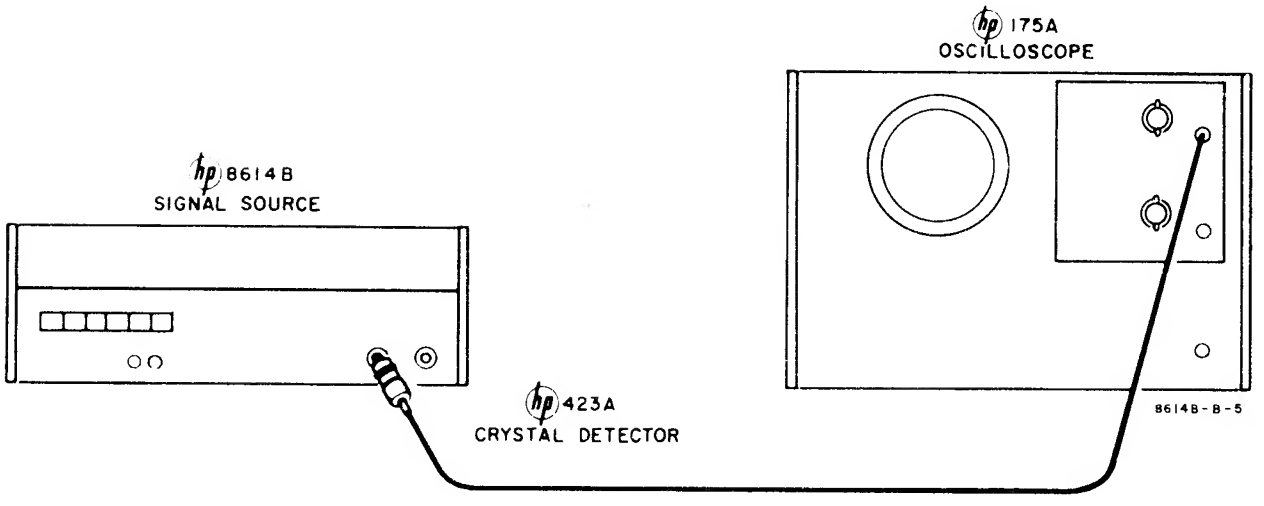


Figure 5-12. Square-Wave Modulation Adjust

c. Set oscilloscope sweep time to .1 MS/CM. Note: Oscilloscope vertical input should be shunted with about 200 ohms for best square-wave presentation.

d. Symmetry should be 45/55% or better. Symmetry may be adjusted with Symmetry Adjust R410 (see Figure 5-2). Square modulation range should be at least 940 to 1060 cps (period range of about 0.94 to 1.07 msec.

5-43. POWER ADJUSTMENT.

a. With Signal Source turned off, measure resistance between each RF OUTPUT connector center conductor and chassis ground. Specification: Resistance should be about 55 ohms for all settings of the ATTENUATOR (DB) dial. If probe is open or shorted at any point, the probe is defective and should be replaced (refer to Paragraph 5-27).

b. Set up Signal Source as follows:

LINE	depressed
RF	depressed
ATTENUATION (DB)	full clockwise
FREQUENCY (MC)	800 (8614B); 1800 (8616B)

c. Using a Power Meter/Thermistor Mount, connect a calibrated 10-db fixed attenuator between the Signal Source and the Power Meter/Thermistor Mount combination and measure maximum RF power output. Specification: VARIABLE RF OUTPUT, the attenuation of fixed attenuator plus meter reading must be +11.8 dbm (+3.0 dbm for 8616B between 3.0 and 4.5 Gc); FIXED RF OUTPUT, attenuation of fixed attenuator plus meter reading must be -3.0 dbm.

d. If measurements are satisfactory, no adjustment is necessary. If either is unsatisfactory, adjust FIXED RF probe adjust screw or attenuator drive shaft bevel gear as appropriate (see Figure 5-8). The Probe Adjust is for the FIXED RF OUTPUT.

5-44. PERFORMANCE CHECKS.

5-45. The performance check procedures are used to check the instrument against its specifications. All checks are made from the front panel, thus the instrument panels need not be removed. The procedure is useful as an incoming or outgoing quality control check, periodic maintenance, or after-repair check.

5-46. FREQUENCY AND POWER CHECK.

a. Connect equipment as shown in Figure 5-13.

b. Set up Signal Source as follows:

LINE	depressed
RF	depressed
ΔF	centered
FREQUENCY (MC)	800 (8614B); 1800 (8616B)

c. Set Power Meter for a mid-scale reading.

d. Using calibrated Frequency Meter, measure actual signal frequency. Specification: For 8614B, accuracy must be ±5 Mc or ±1/2%, whichever is greater; for 8616B, accuracy must be ±10 Mc. Note: Frequency Meter must be calibrated to an accuracy of approximately ±0.03% for the 8614B and ±0.06% for the 8616B.

e. Repeat above procedure every 100 Mc and at all points of particular interest to a frequency dial indication of 2400 Mc for the 8614B and 4500 Mc for the 8616B.

f. If dial accuracy is not within specification, refer to Paragraph 5-40 for adjustment procedure.

g. To check ΔF control: Turn ΔF full counterclockwise and measure output frequency; then turn control full clockwise and measure output frequency. Specification: The difference between readings should be approximately 2 Mc. If ΔF control operation is not satisfactory, refer to Modulation and Klystron Circuits schematic diagram, Figure 5-15 and check potentiometer resistance and power supply voltages.

h. To check power output: Remove Frequency Meter from test setup and measure maximum power output at both FIXED and VARIABLE RF OUTPUT connectors. Specification: The sum of attenuation of 10-db

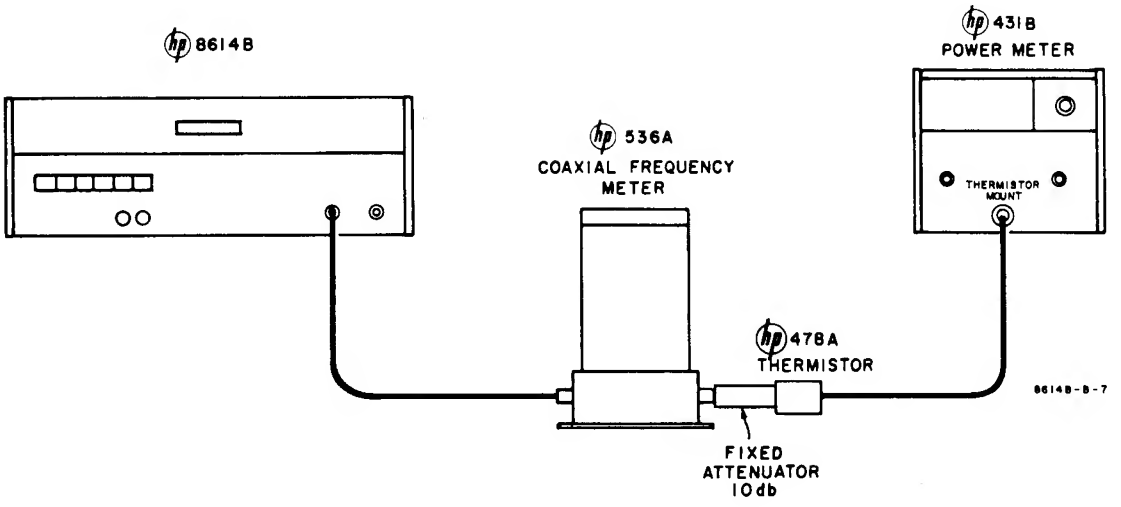


Figure 5-13. Frequency and Power Measurement

attenuator plus Power Meter reading must be at least +11.8 dbm (+3 dbm for 8616B between 3.0 and 4.5 Gc) at VARIABLE RF OUTPUT. The attenuator attenuation and meter reading must equal at least -3.0 dbm at FIXED RF OUTPUT. If either output is not satisfactory, refer to Paragraphs 5-15 and 5-43.

5-47. PULSE MODULATION CHECK.

a. Connect instruments as shown in Figure 5-11.

b. Set up Signal Source as follows:

LINE	depressed
RF	depressed
EXT PULSE	depressed

c. Set up Pulse Generator for a +25-volt 50-prf signal with a pulse width of 2 μsec.

d. A pulse presentation should be seen on the oscilloscope. Specification: Rise Time, 0.3 μsec; Decay Time, 0.5 μsec.

e. Set up Pulse Generator for a +25-volt 5000-prf signal with a pulse width of 2 μsec.

f. A pulse presentation should be seen on the oscilloscope. Specification: Rise Time, 0.3 μsec; Decay Time, 0.5 μsec.

g. If pulse operation is not satisfactory, refer to Paragraph 5-41.

5-48. SQUARE-WAVE MODULATION AND SYNC CHECK.

a. Connect instruments as shown in Figure 5-12.

b. Set up Signal Source as follows:

LINE	depressed
RF	depressed
INT SQ WAVE	depressed
ATTENUATION (DB)	0 DB
SQ WAVE FREQ	full counterclockwise

c. Set oscilloscope sweep time to .1 MC/CM. Note: Oscilloscope vertical input should be shunted with about 200 ohms for best presentation.

d. Readjust rate control to display one complete square wave on oscilloscope. Square wave symmetry should be better than 45/55%. Range should be 950 to 1050 cps. If square wave operation is not satisfactory, refer to Paragraph 5-42.

e. To check external synchronization, connect equipment as shown in Figure 5-11.

f. With Signal Source set up as detailed in step b above, set Pulse Generator as follows:

AMPLITUDE	2.0
LENGTH (μSEC)	1
SYNC SELECTOR	X10
PULSE RATE	100
POLARITY	(+)

g. Set Oscilloscope to INT TRIGGER SOURCE and adjust SQ WAVE FREQ for a period of 1 ±0.02 ms.

h. Set Oscilloscope to EXT AC TRIGGER INPUT and depress PULSE button. Slowly increase PULSE RATE of Pulse Generator until square wave presentation on Oscilloscope becomes stationary. If synchronization operation is not satisfactory, refer to Paragraph 4-9 and schematic diagram Figure 5-15 and check circuit operation.

5-49. MEASUREMENT OF FREQUENCY STABILITY.

5-50. A Dymec 2590A, used as an FM Monitor, will measure the incidental FM in the Signal Generator output. Another method, which is more complicated, involves using a "FM-free Source", such as a Ⓗ Model 8614A and a Dymec Model 2650A with a 20-kc Low-Pass Filter on the 2650A output.

Note

The outputs of the "FM-free Source" must be heterodyned with the output of the 8614A under test. The heterodyned output must then be detected and amplified by an AC amplifier with a 100-kc bandwidth. A frequency deviation measurement must then be performed (see Hewlett-Packard Application Note 1 and/or the Ⓗ Model 500B Frequency Meter Operating and Service Manual for detail).

NOTES

1. RESISTANCE IN OHMS; CAPACITANCE IN MICROFARDS UNLESS OTHERWISE INDICATED
2. ALL SWITCHES SHOW IN THE "ON" POSITION
3. ——·--·—— INDICATES PRINTED CIRCUIT BOARD. THE NUMBER ADJACENT TO LEADS LEAVING THE BOARD ARE LOCATED ON THE PRINTED CIRCUIT BOARD SIDE
4. ⊘ INDICATES SCREWDRIVER ADJUSTMENT
5. CW INDICATES POSITION OF ADJUSTABLE CONTACT AT THE LIMIT OF CLOCKWISE TRAVEL IS VIEWED FROM THE KNOB END OF THE POTENTIOMETER
6. Δ= 8616B VALUE, UNMARKED VALUE FOR 8614B
7. ⬠ INDICATES A TEST POINT

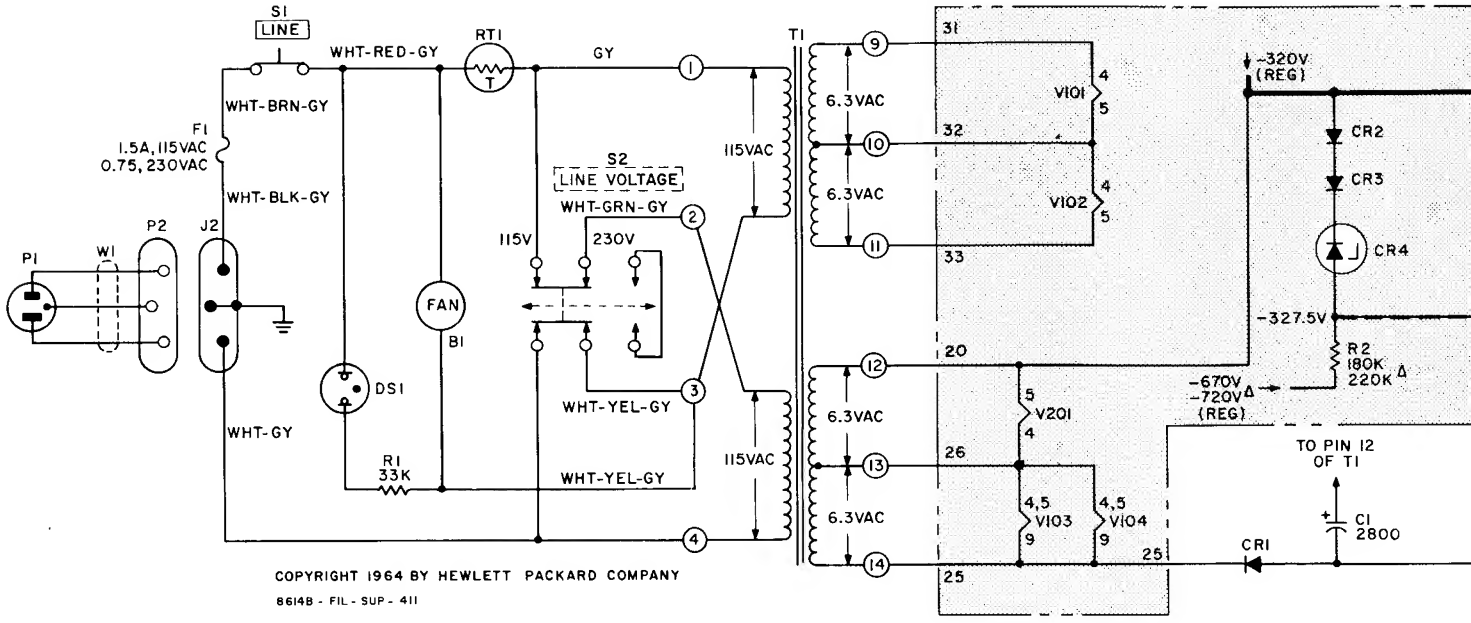
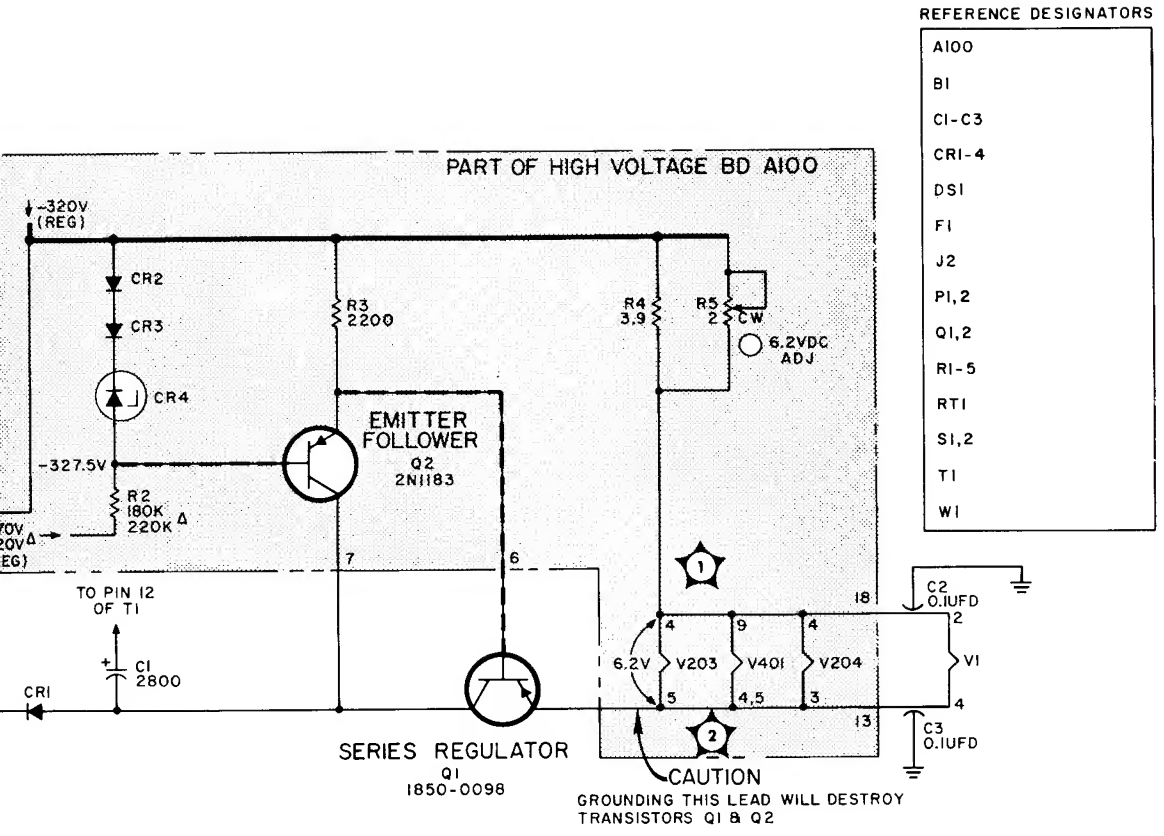
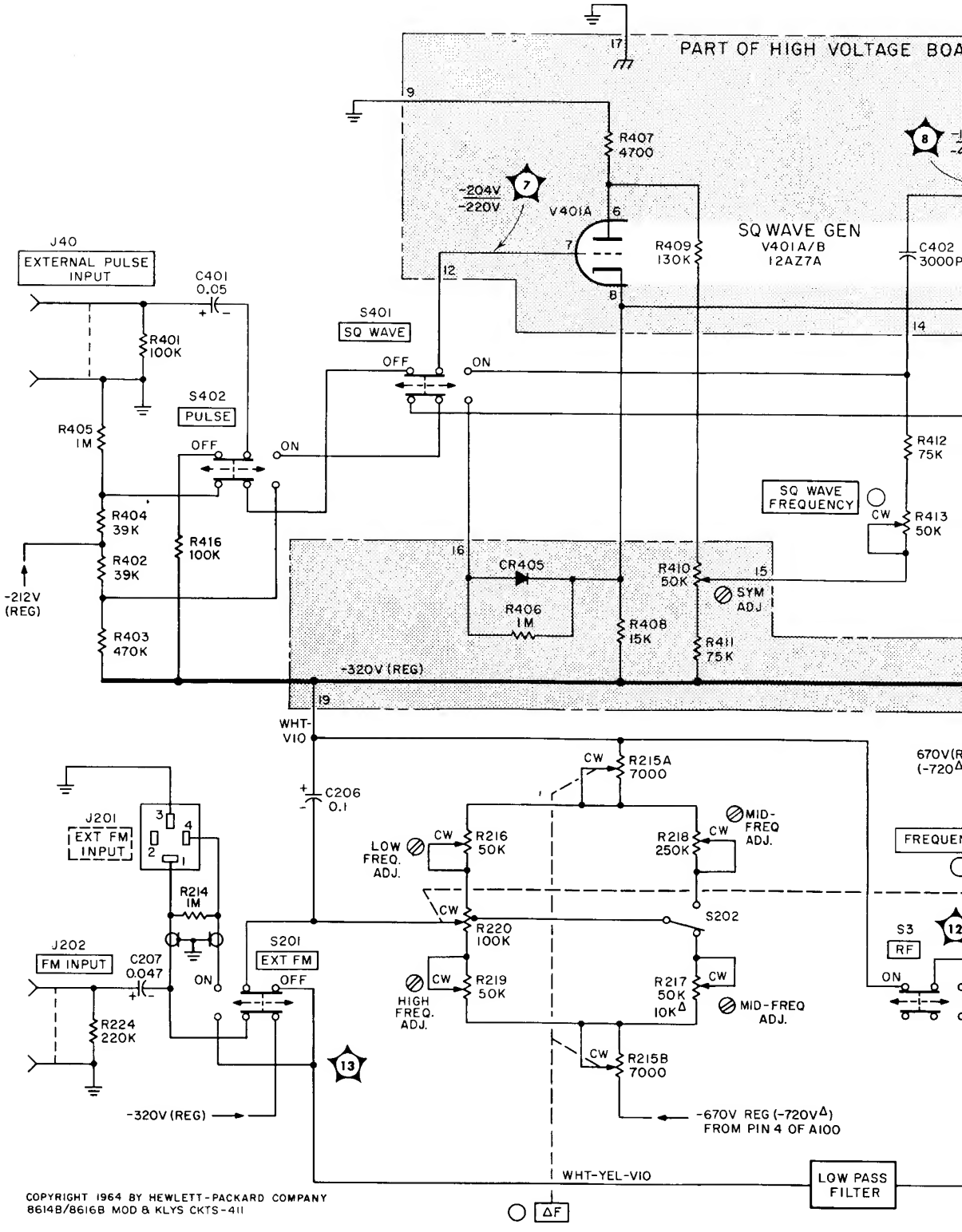


Figure 5-14. Regulated Filament Supply


REFERENCE DESIGNATORS
A100
B1
C1-C3
CR1-4
DS1
F1
J2
P1,2
Q1,2
R1-5
RT1
S1,2
T1
W1
PART OF HIGH VOLTAGE BD A100
-320V (REG)
CR2
CR3
CR4
R3 2200
R4 3.9
R5 2 CW
6.2VDC ADJ
EMITTER FOLLOWER Q2 2N1183
-327.5V
R2 180K 220K Δ
7
6
TO PIN 12 OF T1
C1 2800
CR1
SERIES REGULATOR Q1 1850-0098
1
2
18
C2 0.1UFD
4
9
4
2
6.2V
V203
V401
V204
V1
5
4,5
3
4
13
C3 0.1UFD
CAUTION
GROUNDING THIS LEAD WILL DESTROY TRANSISTORS Q1 & Q2



86148/8616B MOD 8 KLYS CKTS-411

NOTES:

1. CAPACITANCE IN MICROFARADS AND RESISTANCE IN OHMS UNLESS OTHERWISE INDICATED.
2. ——— – – ——— INDICATES A PRINTED CIRCUIT BOARD. NUMBERS ADJACENT TO LEADS LEAVING BOARD ARE LOCATED ON THE PRINTED CIRCUIT SIDE OF THE BOARD.
3. ▭ INDICATES FRONT PANEL CONTROL.
4. ○ INDICATES FRONT PANEL ROTARY SWITCH OR POTENTIOMETER.
5. ⊘ INDICATES A SCREWDRIVER ADJUSTMENT.
6. * FACTORY SELECTED VALUE.
7. Δ= 8616B VALUE, UNMARKED VALUE FOR 8614B.
8. ✶ INDICATES TEST POINT; FRACTIONS INDICATE CONTINUOUS WAVE OPERATION (TOP VOLTAGE) AND PULSE OPERATION WITH NO PULSE INPUT APPLIED (BOTTOM VOLTAGE).

REFERENCE DESIGNATORS

C4, 206-207, 401-402
CR401-406
J3-4, 201-202, 401
Q401-402
R214-220, 224, 401-421
S3, 201-202, 401-402
V1, V401

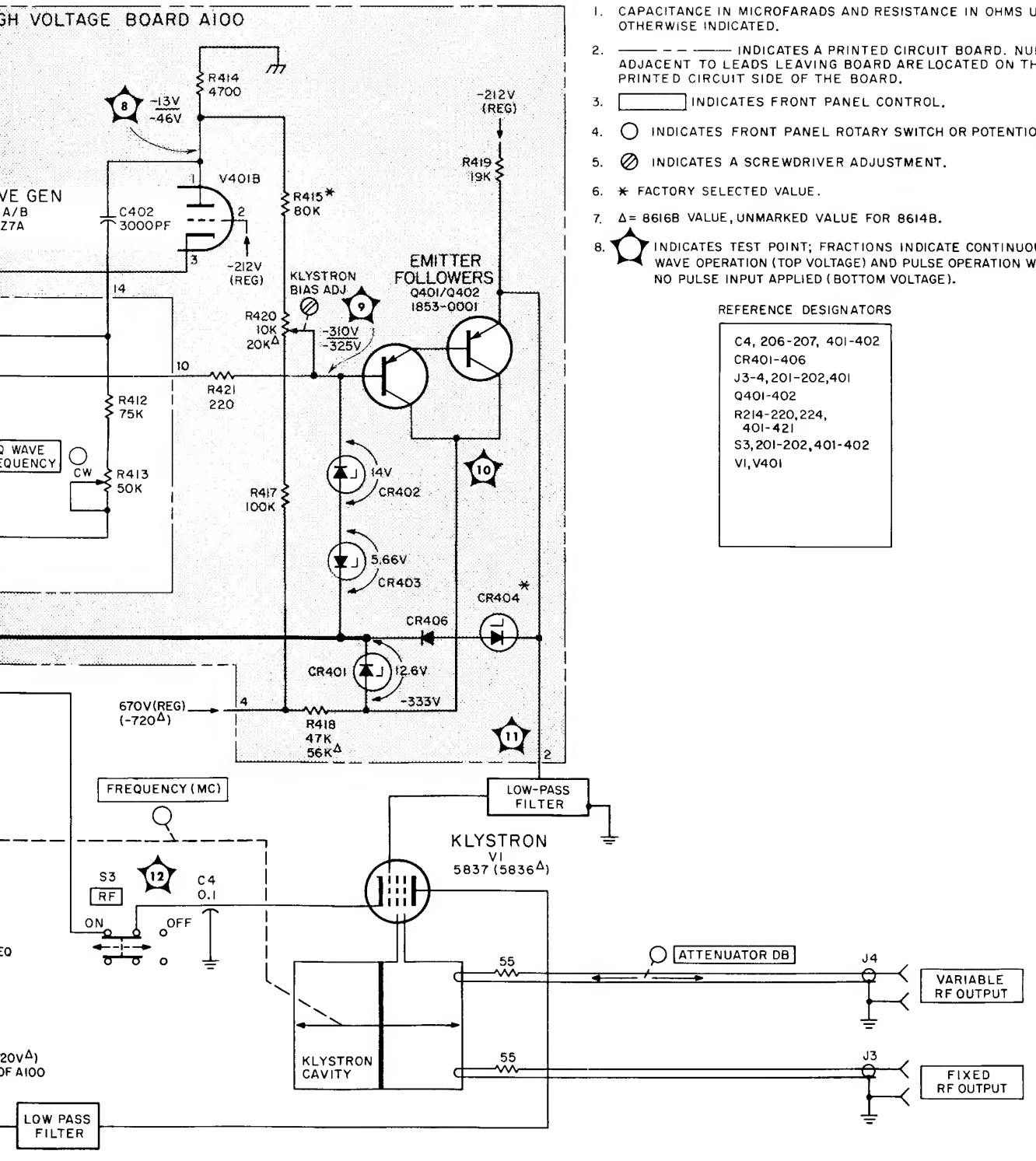
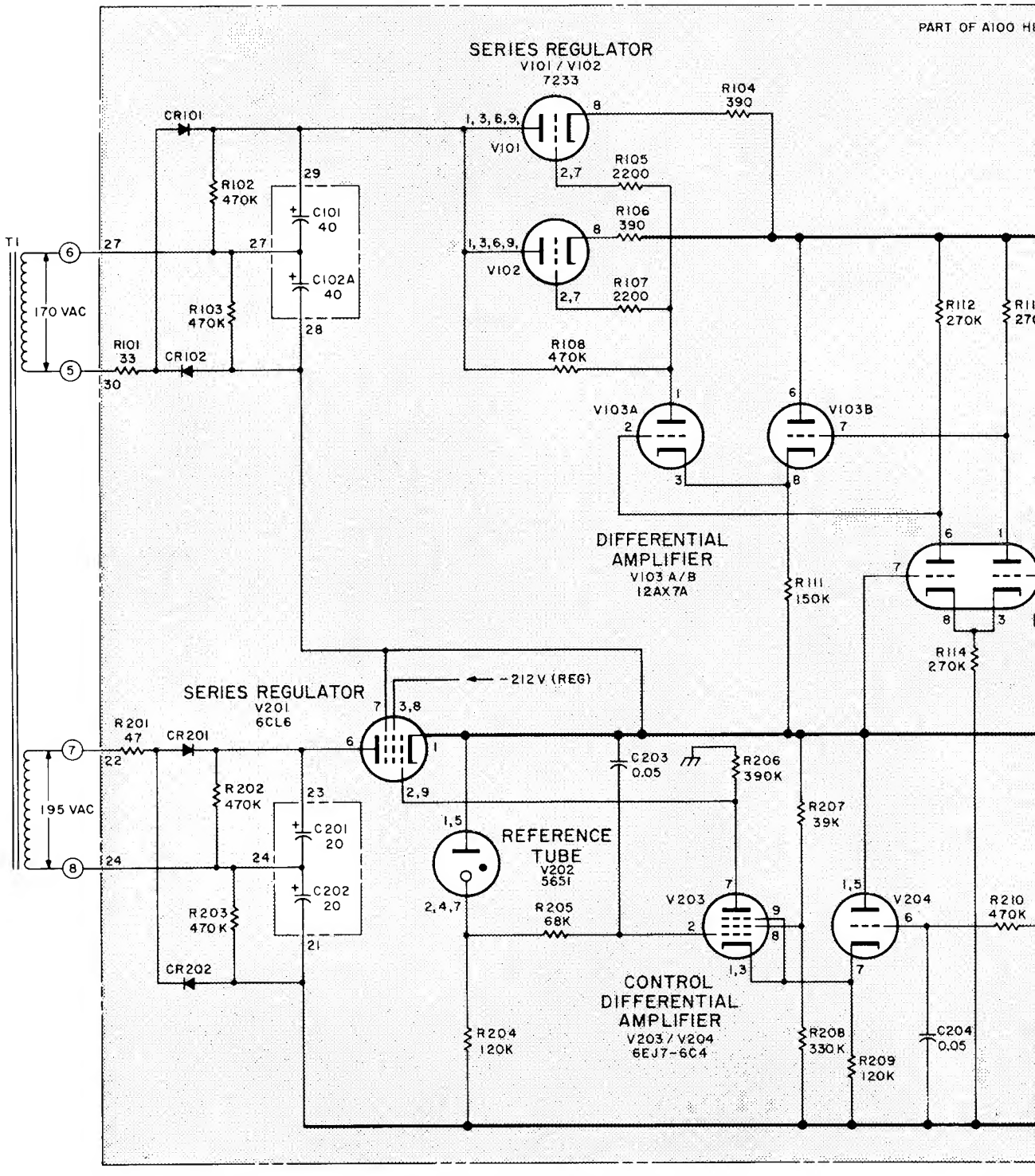


Figure 5-15. Modulation and Klystron Circuits


PART OF A100 HE
SERIES REGULATOR
V101 / V102
7233
V101
V102
R104
390
R105
2200
R106
390
R107
2200
R108
470K
CR101
R102
470K
C101
40
C102A
40
R103
470K
R101
33
CR102
T1
170 VAC
R112
270K
V103A
V103B
DIFFERENTIAL
AMPLIFIER
V103 A/B
12AX7A
R111
150K
R114
270K
-212 V (REG)
SERIES REGULATOR
V201
6CL6
R201
47
CR201
R202
470K
C201
20
C202
20
R203
470K
CR202
195 VAC
C203
0.05
R206
390K
R207
39K
REFERENCE
TUBE
V202
5651
R205
68K
V203
V204
R210
470K
CONTROL
DIFFERENTIAL
AMPLIFIER
V203 / V204
6EJ7-6C4
R204
120K
R208
330K
R209
120K
C204
0.05

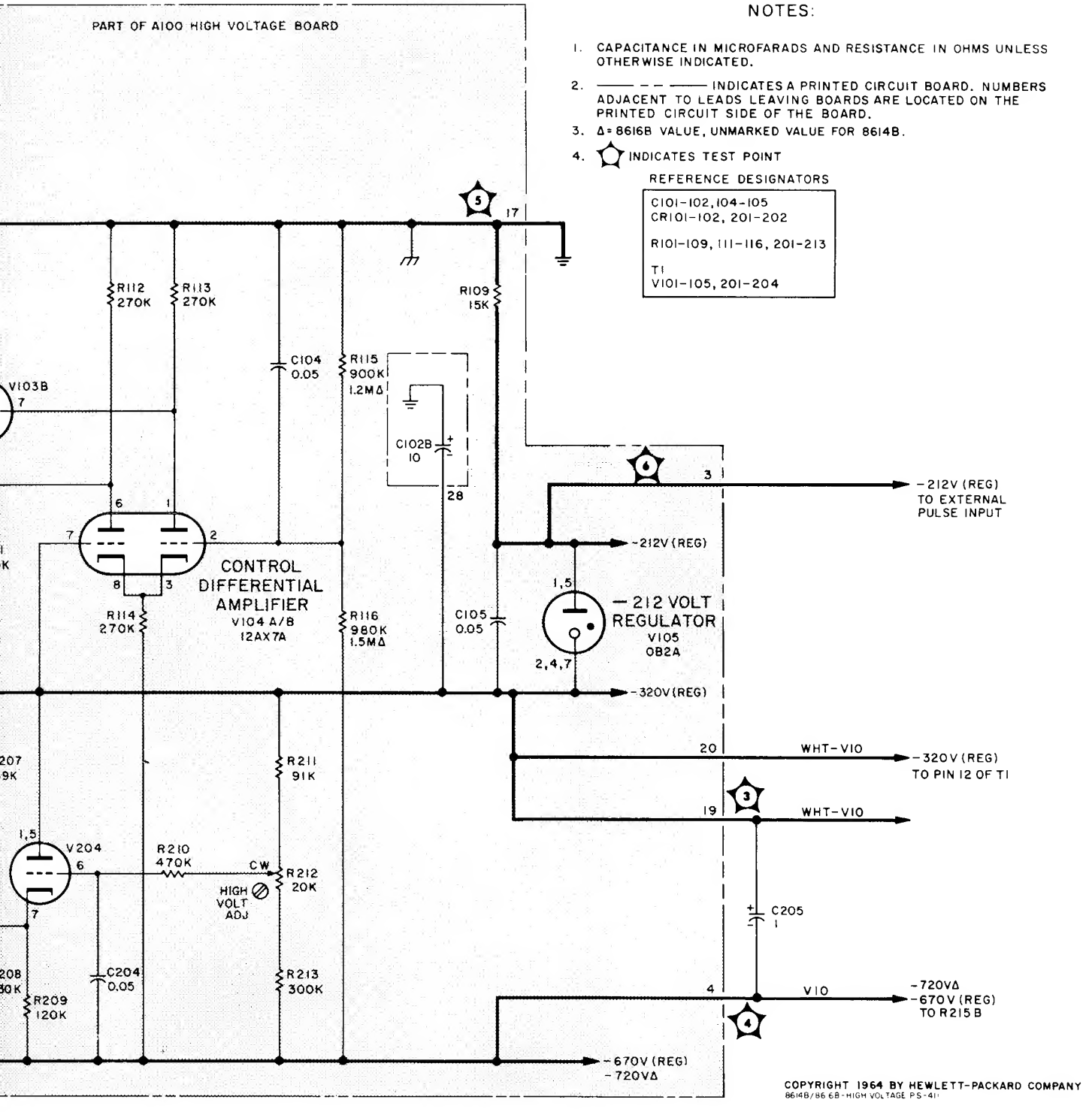


Figure 5-16. High-Voltage Power Supply

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designations and indicates the description and hp stock number of each part, together with any applicable notes. Table 6-2 lists parts in numerical order of their hp stock numbers and provides the following information for each part:

a. Description of part (see list of abbreviations below).

b. Typical manufacturer of part in a five-digit code; see list of manufacturers in appendix.

c. Manufacturer's stock number.

d. Total quantity used in instrument (TQ column).

6-3. Miscellaneous and cabinet parts not indexed by reference designations are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To order a replacement part, address order or inquiry to your nearest Hewlett - Packard field office (see maps at rear of manual).

6-6. Specify the following information for each part:

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designation

d. Description.

6-7. To order a part not listed in Tables 6-1 and 6-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	FL	= filter	Q	= transistor		
C	= capacitor	J	= jack	R	= resistor	W	= cable
CR	= diode	K	= relay	RT	= thermistor	X	= socket
DL	= delay line	L	= inductor	S	= switch	Y	= crystal
DS	= device signaling (lamp)	M	= meter	T	= transformer	Z	= network
E	= misc electronic part	MP	= mechanical part				

ABBREVIATIONS

A	= amperes	ELECT	= electrolytic	MOM	= momentary	RH	= round head
A.F.C	= automatic frequency control	ENCAP	= encapsulated	MTG	= mounting	RMO	= rack mount only
AMP	= amplifier			MY	= mylar	RMS	= root-mean-square
		F	= farads			ROT	= rotary
B.F.O.	= beat frequency oscillator	FH	= flat head	NC	= normally closed		
BE CU	= beryllium copper	FIL H	= fillister head	NE	= neon	S-B	= slow-blow
BH	= binder head	FXD	= fixed	NI PL	= nickel plate	SE	= selenium
BP	= bandpass			NO	= normally open	SECT	= section(s)
BRS	= brass	GE	= germanium	NPO	= negative positive zero (zero temperature coefficient)	SEMICON	= semiconductor
BWO	= backward wave oscillator	GL	= glass			SI	= silicon
		GRD	= ground(ed)	NSR	= not separately replaceable	SIL	= silver
CER	= ceramic					SL	= slide
CMO	= cabinet mount only	H	= henries			SPL	= special
COEF	= coefficient	HEX	= hexagonal	OBD	= order by description	SST	= stainless steel
COM	= common	HG	= mercury	OH	= oven head		
COMP	= composition	HR	= hour(s)	OX	= oxide	TA	= tantalum
CONN	= connector					TD	= time delay
CP	= cadmium plate	IMPG	= impregnated	P	= peak	TI	= titanium
CRT	= cathode-ray tube	INCD	= incandescent	PC	= printed circuit board	TOG	= toggle
DEPC	= deposited carbon	INS	= insulation(ed)	PF	= picofarads = 10^{-12} farads	TOL	= tolerance
EIA	= Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by hp stock numbers.	K	= kilo = 1000	PH BRZ	= phosphor bronze	TRIM	= trimmer
				PIV	= peak inverse voltage	TWT	= traveling wave tube
		LIN	= linear taper	POLY	= polystyrene	U	= micro = 10^{-6}
		LK	= lock	POR	= porcelain		
		LOG	= logarithmic taper	POS	= position(s)	VAC	= vacuum
		LPF	= low pass filter	POT	= potentiometer	VAR	= variable
		M	= milli = 10^{-3}	PP	= peak-to-peak		
		MEG	= meg = 10^{6}	PT	= point	W	= watts
		METFLM	= metal film			W/	= with
		MFR	= manufacturer	RECT	= rectifier	W/O	= without
		MINAT	= miniature	RF	= radio frequency	WW	= wirewound

01194-8

Table 6-1. Reference Designation Index

Circuit Reference	Stock No.	Description	Note
A100	08614-616	HIGH VOLTAGE BOARD(8614B ONLY)	
A100	08616-607	HIGH VOLTAGE BOARD(8616B ONLY)	
	08614-291	BLANK BOARD:HIGH VOLTAGE	
C1	0180-0128	C:FXD ELECT 2800 UF +50-20%	
C2	0160-0152	C:FXD PAPER 0.1 UF 20% 600VDCW	
C3	0160-0152	C:FXD PAPER 0.1 UF 20% 600VDCW	
C4	0160-0152	C:FXD PAPER 0.1 UF 20% 600VDCW	
C5 THRU C100		NOT ASSIGNED	
C101	0180-0024	C:FXD ELECT 40 UF +50-10% 450VDCW	
C102	0180-0135	C:FXD ELECT 40-10 UF +50-10% 450VDCW	
C103		NOT ASSIGNED	
C104	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C105	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C106 THRU C200		NOT ASSIGNED	
C201	0180-0011	C:FXD ELECT 20 UF 450VDCW	
C202	0180-0011	C:FXD ELECT 20 UF 450VDCW	
C203	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C204	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C205	0160-0079	C:FXD PAPER 1.0 MF 10% 600VDCW	
	1210-0003	CAPACITOR BRACKET FOR C205	
C206	0170-0022	C:FXD MY 0.1 UF 20% 600VDCW	
C207	0160-0056	C:FXD 0.047 UF 10% 1000VDCW	
C208 THRU C400		NOT ASSIGNED	
C401	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C402	0140-0159	C:FXD MICA 3000 PF 2% 300VDCW	
CR1	1901-0032	SEMICON DEVICE:DIODE SILICON 1N3209	
CR2	1901-0025	SEMICON DEVICE:DIODE SILICON	
CR3	1901-0025	SEMICON DEVICE:DIODE SILICON	
CR4	1902-0057	SEMICON DEVICE:DIODE ZENER	
CR5 THRU CR100		NOT ASSIGNED	
CR101	1901-0030	SEMICON DEVICE:DIODE SILICON	
CR102	1901-0030	SEMICON DEVICE:DIODE SILICON	
CR103 THRU CR200		NOT ASSIGNED	
CR201	1901-0030	SEMICON DEVICE:DIODE SILICON	
CR202	1901-0030	SEMICON DEVICE:DIODE SILICON	
CR203 THRU CR400		NOT ASSIGNED	
CR401	1902-0031	SEMICON DEVICE:DIODE ZENER	
CR402	1902-0040	SEMICON DEVICE:DIODE ZENER	
CR403	1902-0032	SEMICON DEVICE:DIODE ZENER	
CR404		FACTORY SELECTED COMPONENT	
CR405	1901-0025	SEMICON DEVICE:DIODE SILICON	
CR406	1901-0025	SEMICON DEVICE:DIODE SILICON	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
DS1	1450-0039	LIGHT:INDICATOR NE-2H NEON	
F1	2110-0033	FUSE:.75 A 250V(230V OPERATION)	
F1	2110-0043	FUSE:1.5A 250V (115V OPERATION)	
J2	1251-0148	CONNECTOR:AC POWER,3 PIN MALE	
J3		PART OF PROBE CONNECTOR ASSEMBLY	
J4		PART OF PROBE CONNECTOR ASSEMBLY	
J5 THRU J200		NOT ASSIGNED	
J201	1251-0011	CONNECTOR:FEMALE 4 CONTACTS	
J202	1250-0160	CONNECTOR:BNC FEMALE	
J203 THRU J400		NOT ASSIGNED	
J401	1250-0160	CONNECTOR:BNC FEMALE	
Q1	1850-0098	TRANSISTOR:GERMANIUM PNP	
Q2	1850-0064	TRANSISTOR:GERMANIUM PNP 2N1183	
Q3 THRU Q400		NOT ASSIGNED	
Q401	1853-0001	TRANSISTOR:SILICON PNP	
Q402	1853-0001	TRANSISTOR: SILICON PNP	
R1	0687-3331	R:FXD COMP 33K OHM 10% 1/2W	
R2	0690-2241	R:FXD COMP 220K OHM 10% 1W(8616B ONLY)	
R2	0690-1841	R:FXD COMP 180K OHM 10% 1W(8614B ONLY)	
R3	0687-2221	R:FXD COMP 2.2K OHM 10% 1/2W	
R4	0813-0030	R:FXD WW 3.9 OHM 10% 3W	
R5	2100-0317	R:VAR WW 2 OHM 20% LIN 3W	
R6 THRU R100		NOT ASSIGNED	
R101	0693-3301	R:FXD COMP 33 OHM 10% 2W	
R102	0687-4741	R:FXD COMP 470K OHM 10% 1/2W	
R103	0687-4741	R:FXD COMP 470K OHM 10% 1/2W	
R104	0690-3911	R:FXD COMP 390 OHM 10% 1W	
R105	0687-2221	R:FXD COMP 2.2K OHM 10% 1/2W	
R106	0690-3911	R:FXD COMP 390 OHM 10% 1W	
R107	0687-2221	R:FXD COMP 2.2K OHM 10% 1/2W	
R108	0687-4741	R:FXD COMP 470K OHM 10% 1/2W	
R109	0773-0005	R:FXD MET OX 12K OHM 5% 5W	
R110		NOT ASSIGNED	
R111	0690-1541	R:FXD COMP 150K OHM 10% 1W	
R112	0690-2741	R:FXD COMP 270K OHM 10% 1W	
R113	0690-2741	R:FXD COMP 270K OHM 10% 1W	
R114	0690-2741	R:FXD COMP 270K OHM 10% 1W	
R115	0727-0259	R:FXD DEPC 900K OHM 1% 1/2W(8614B ONLY)	
R115	0727-0280	R:FXD DEPC 1.2 MEGOHM 1% 1/2W(8616B ONLY)	
R116	0727-0267	R:FXD DEPC 980K OHM 1% 1/2W(8614B ONLY)	
R116	0727-0282	R:FXD DEPC 1.5 MEGOHM 1% 1/2W(8616B ONLY)	
R117 THRU R200		NOT ASSIGNED	
R201	0693-4701	R:FXD COMP 47 OHM 10% 2W	
R202	0687-4741	R:FXD COMP 470K OHM 10% 1/2W	
R203	0687-4741	R:FXD COMP 470K OHM 10% 1/2W	
R204	0690-1241	R:FXD COMP 120K OHM 10% 1W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R205	0687-6831	R:FXD COMP 68K OHM 10% 1/2W	
R206	0690-3941	R:FXD COMP 390K OHM 10% 1W	
R207	0687-3931	R:FXD COMP 39K OHM 10% 1/2W	
R208	0690-3341	R:FXD COMP 330K OHM 10% 1W	
R209	0690-1241	R:FXD COMP 120K OHM 10% 1W	
R210	0687-4741	R:FXD COMP 470K OHM 10% 1/2W	
R211	0758-0052	R:FXD MET OX 91K OHM 5% 1/2W	
R212	2100-0093	R:VAR COMP 20K OHM 20% LIN 1/5W	
R213	0761-0017	R:FXD MET OX 300K OHM 5% 1W	
R214	0687-1051	R:FXD COMP 1 MEGOHM 10% 1/2W	
R215	2100-0411	R:VAR COMP 2 X 7K OHM 10% LIN 1/2W	
R216	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	
R217	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W(8614B ONLY)	
R217	2100-0027	R:VAR COMP 10K OHM 10% LIN 2W(8616B ONLY)	
R218	2100-0029	R:VAR COMP 250K OHM 10% LIN 2W	
R219	2100-0028	R:VAR COMP 50K OHM 10% LIN 2W	
R220	2100-0399	R:VAR WW 100K OHM	
R221 THRU R223		NOT ASSIGNED	
R224	0687-2241	R:FXD COMP 220K OHM 10% 1/2W	
R225 THRU R400		NOT ASSIGNED	
R401	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R402	0687-3931	R:FXD COMP 39K OHM 10% 1/2W	
R403	0687-4741	R:FXD COMP 470K OHM 10% 1/2W	
R404	0687-3931	R:FXD COMP 39K OHM 10% 1/2W	
R405	0687-1051	R:FXD COMP 1 MEGOHM 10% 1/2W	
R406	0687-1051	R:FXD COMP 1 MEGOHM 10% 1/2W	
R407	0686-4725	R:FXD COMP 4700 OHM 5% 1/2W	
R408	0693-1531	R:FXD COMP 15K OHM 10% 2W	
R409	0686-1345	R:FXD COMP 130K OHM 5% 1/2W	
R410	2100-0094	R:VAR COMP 50K OHM 30% LIN-35%	
R411	0686-7535	R:FXD COMP 75K OHM 5% 1/2W	
R412	0686-7535	R:FXD COMP 75K OHM 5% 1/2W	
R413	2100-0044	R:VAR COMP 50K OHM 10% LIN 2W	
R414	0686-4725	R:FXD COMP 4700 OHM 5% 1/2W	
R415	0730-0062	R:FXD DEPC 80K OHM 1% 1W FACTORY SELECTED COMP;TYPICAL VALUE GIVEN	
R416	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R417	0764-0028	R:FXD MET OX 100K OHM 5% 2W	
R418	0770-0009	R:FXD MET OX 47K OHM 5% 4W(8614B ONLY)	
R418	0770-0013	R:FXD MET OX 56K OHM 5% 4W(8616B ONLY)	
R419	0730-0037	R:FXD DEPC 19K OHM 1% 1W	
R420	2100-0092	R:VAR COMP 10K OHM 20% LIN-25%(8614B ONLY)	
R420	2100-0093	R:VAR COMP 20K OHM 20% LIN 1/5W(8616B ONLY)	
R421	0687-2211	R:FXD COMP 220 OHM 10% 1/2W	
RT1	0839-0020	THERMISTOR:DISC 100 OHM 10%	
S1	3101-0042	SWITCH:PUSHBUTTON SPST	
S2	3101-0033	SWITCH:SLIDE DPDT(115-230)	
S3	3101-0043	SWITCH:PUSHBUTTON DPDT	
S4 THRU S200		NOT ASSIGNED	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
S201	3101-0043	SWITCH:PUSHBUTTON DPDT	
S202	3102-0009	SWITCH:MICRO SPDT 5A	
S203 THRU S400		NOT ASSIGNED	
S401	3101-0043	SWITCH:PUSHBUTTON DPDT	
S402	3101-0043	SWITCH:PUSHBUTTON DPDT	
T1	9100-0176	TRANSFORMER:POWER	
V1	1950-0003	ELECTRON TUBE:KLYSTRON 5837(8614B ONLY)	
V1	1950-0018	ELECTRON TUBE:KLYSTRON 5836(8616B ONLY)	
V2 THRU V100		NOT ASSIGNED	
V101	1921-0014	ELECTRON TUBE:TRIODE 7233	
V102	1921-0014	ELECTRON TUBE:TRIODE 7233	
V103	1932-0030	ELECTRON TUBE:DUAL TRIODE 12AX7A	
V104	1932-0030	ELECTRON TUBE:DUAL TRIODE 12AX7A	
V105	1940-0007	ELECTRON TUBE:0B2	
V106 THRU V200		NOT ASSIGNED	
V201	1923-0030	ELECTRON TUBE:6CL6	
V202	1940-0001	ELECTRON TUBE:5651	
V203	1923-0046	ELECTRON TUBE:6EJ7	
V204	1921-0005	ELECTRON TUBE:TRIODE 6C4	
V205 THRU V400		NOT ASSIGNED	
V401	1932-0048	ELECTRON TUBE:EIA TYPE 12AZ7A	
W1	8120-0078	CABLE:POWER	
XV101	1200-0062	SOCKET:TUBE 9 PIN	
XV102	1200-0062	SOCKET:TUBE 9 PIN	
XV103	1200-0062	SOCKET:TUBE 9 PIN	
XV104	1200-0062	SOCKET:TUBE 9 PIN	
XV105	1200-0053	SOCKET:TUBE 7 PIN	
XV106 THRU XV200		NOT ASSIGNED	
XV201	1200-0062	SOCKET:TUBE 9 PIN	
XV202	1200-0053	SOCKET:TUBE 7 PIN	
XV203	1200-0062	SOCKET:TUBE 9 PIN	
XV204	1200-0053	SOCKET:TUBE 7 PIN	
XV205 THRU XV400		NOT ASSIGNED	
XV401	1200-0062	SOCKET:TUBE 9 PIN	

See introduction to this section

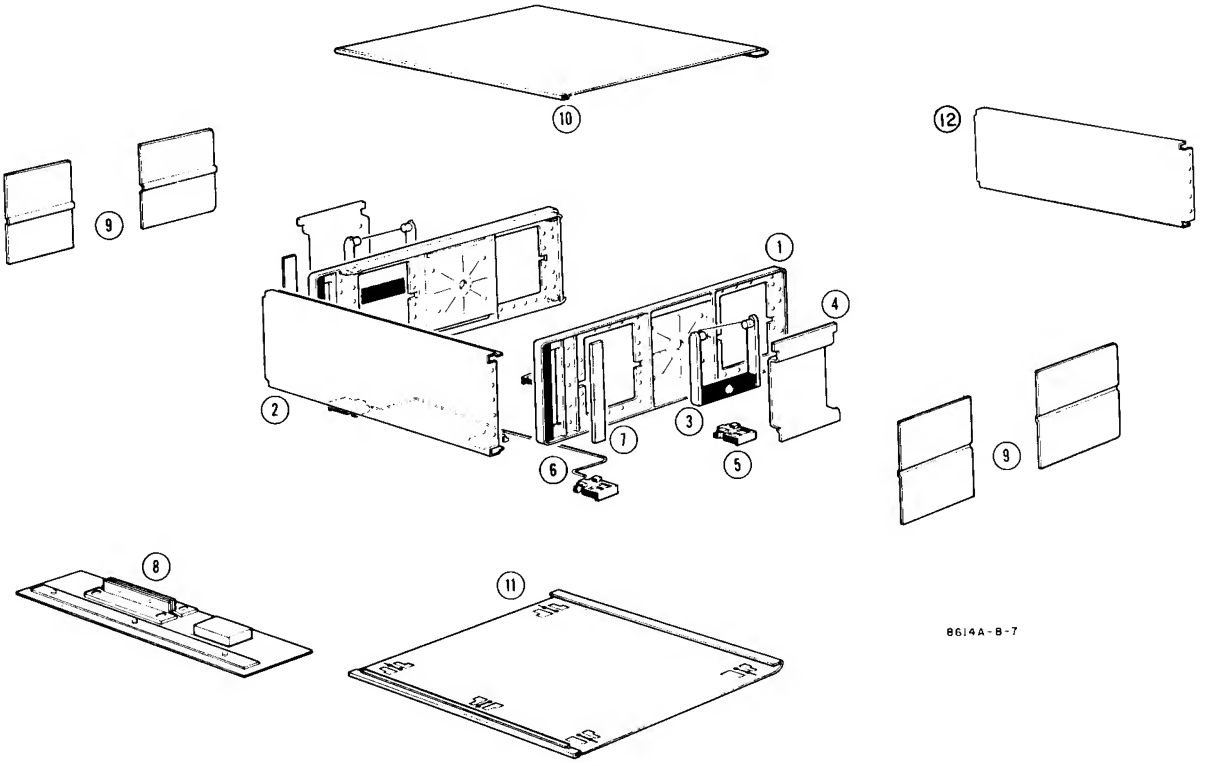
Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	℗ Stock No.	Description	Note
		MISCELLANEOUS	
	08614-611	ASSY:INTAKE AIR CLEANER	
	08614-612	ASSY:SHIELDED FAN	
	08614-264	ASSEMBLY,WIPER	
	5040-0201	BEZEL,COUNTER(ATTEN)	
	5040-0202	BEZEL:COUNTER(FREQ)	
	08614-260	CAM,FREQUENCY	
	08614-261	CAM,LENGTH	
	08614-615	CAVITY ASSEMBLY(8614B ONLY)	
	08616-606	CAVITY ASSEMBLY(8616B ONLY)	
	08614-017	CHASSIS,MAIN	
	5020-0306	COUPLING NUT P/O PLUG TYPE N CONNECTOR	
	5040-0417	CLAMP HOLDER, 9 PIN FOR XV101,XV102	
	1400-0071	CLAMP:TUBE FOR PRINTED CIRCUIT SOCKETS	
	08614-282	CONDUCTOR:CENTER	
	1250-0144	BODY,CONNECTOR P/O PROBE CONNECTOR ASSY.	
	1251-0053	CONNECTOR,TAPER(TEST POINT)FEMALE	
	1200-0088	INSULATOR:DIODE (CR1)ANODIZED ALUMINUM	
	1200-0043	INSULATOR:TRANSISTOR(Q1)ANODIZED ALUMINUM	
	0370-0050	KNOB:CRANK HANDLE(KNOB NOT INCLUDED)	
	0370-0149	KNOB:CRANK(INCLUDES HANDLE ASSY.)	
	0370-0026	KNOB: ΔF AND SQUARE WAVE	
	5000-0244	LABEL:FM	
	5000-0245	LABEL:PULSE	
	5000-0246	LABEL:SQUARE WAVE	
	5000-0247	LABEL:RF	
	5000-0248	LABEL:LINE	
	1520-0001	MOUNTING PLATE FOR CAPACITOR C1	
	1520-0002	MOUNTING PLATE FOR CAPACITOR C2,C3,C4,C205.	
	5000-0051	PLATE:FLUTED ALUMINUM	
	08614-614	PROBE ASSEMBLY(8614B ONLY)	
	08616-605	PROBE ASSEMBLY(8616B ONLY)	
	08614-227	PLUG,TYPE N CONNECTOR	
	0370-0118	PUSHBUTTON	
	0510-0123	RETAINER:SPRING CLIP FOR DS1	
	2100-0401	TRACKING POT ROTOR	
	2100-0402	TRACKING POT STATOR	
	08614-617	WIRING HARNESS,BRANCHED(AC)	
	08614-618	WIRING HARNESS,BRANCHED(DC)	
		PROBE CONNECTOR ASSEMBLY INCLUDES:	
	1250-0145	GASKET,V GROOVE	
	1250-0146	WASHER,FLAT	
	1250-0147	NUT,RETAINING	
	1250-0148	WASHER,INSULATING	
	1250-0017	CONTACT:FEMALE CENTER PIN	
	1250-0141	BODY,CLAMPING	
	1250-0142	NUT,CLAMP	
	1250-0143	WASHER,SHOULDERED	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

CABINET PARTS



Circuit Reference	Stock No.	Description	Note
1	5060-0732	FRAME ASSEMBLY	
	0590-0053	#6-32 NUT-CAPTIVE,J-TYPE FOR 0.125"	
2	08614-018	FRONT PANEL(8614B ONLY)	
	2530-0011	#8-32 X 3/8" FH SLOT DRIVE W/INTERNAL LOCKWASHER	
2	08616-003	FRONT PANEL(8616B ONLY)	
3	5060-0763	HANDLE ASSEMBLY:SIDE	
4	5060-0766	RETAINER HANDLE	
	2550-0013	#8-32 X 5/16" BH,PHILLIPS DRIVE	
5	5060-0767	FOOT ASSEMBLY	
6	1490-0030	STAND:TILT	
7	5000-0052	TRIM:ALUMINUM	
8	5060-0775	KIT:RACK MOUNTING	
9		COVER:SIDE	
	5000-0738	PERFORATED REAR	
	5000-0739	PERFORATED FRONT	
	2370-0020	#6-32 X 3/16",100°FH,PHILLIPS DRIVE	
10	5060-0740	COVER ASSEMBLY:TOP,UNPERFORATED	
	2370-0021	#6-32 X 7/16",FH,PHILLIPS DRIVE	
11	5060-0752	COVER ASSEMBLY:BOTTOM UNPERFORATED	
	2370-0021	#6-32 X 7/16",FH,PHILLIPS DRIVE	
12	08614-024	REAR PANEL	
	2515-0017	#8-32 X 1/4",RECESSED PHILLIPS DRIVE, PANHEAD W/INTERNAL LOCKWASHER	

See introduction to this section

Table 6-2. Replaceable Parts

℗ Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	
0140-0159	C:FXD MICA 3000 PF 2% 300VDCW	04062	DM19F 302G	1	
0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	56289	33C17A/50000 PF	5	
0160-0056	C:FXD CER 0.047 UF 10% 1000VDCW	56289	160P473910	1	
0160-0079	C:FXD PAPER 1.0 MF 10% 600VDCW	24446	23F467	1	
0160-0152	C:FXD PAPER 0.1 UF 20% 600VDCW	56289	102P25	3	
0170-0022	C:FXD MY 0.1 UF 20% 600VDCW	09134	TYPE 27	1	
0180-0011	C:FXD ELECT 20 UF 450VDCW	28480	0180-0011	2	
0180-0024	C:FXD ELECT 40 UF +50-10% 450VDCW	56289	D32441	1	
0180-0128	C:FXD ELECT 2800 UF +50-10%	00853	505-1010-02	1	
0180-0135	C:FXD ELECT 40-10 UF +50-10% 450VDCW	90853	TYPE LPI	1	
0370-0026	KNOB: F & SQUARE WAVE	28480	0370-0026	2	
0370-0050	KNOB:CRANK HANDLE(KNOB NOT INCLUDED)	28480	0370-0050	1	
0370-0118	PUSHBUTTON	28480	0370-0118	5	
0370-0149	KNOB:CRANK(INCLUDES HANDLE ASSY.)	28480	0370-0149	2	
0510-0123	RETAINER:SPRING CLIP FOR DS1	78553	C12008-014-4	1	
0686-1055	R:FXD COMP 1 MEGOHM 5% 1/2W	01121	EB 1055	1	
0686-1345	R:FXD COMP 130K OHM 5% 1/2W	01121	EB 1345	1	
0686-3335	R:FXD COMP 33K OHM 5% 1/2W	01121	EB 3335	1	
0686-3935	R:FXD COMP 39K OHM 5% 1/2W	01121	EB 3935	1	
0686-4725	R:FXD COMP 4700 OHM 5% 1/2W	01121	EB 4725	2	
0686-4745	R:FXD COMP 470K OHM 5% 1/2W	01121	EB 4745	1	
0686-7535	R:FXD COMP 75K OHM 5% 1/2W	01121	EB 7535	2	
0687-1041	R:FXD COMP 100K OHM 10% 1/2W	01121	EB 1041	2	
0687-1051	R:FXD COMP 1 MEGOHM 10% 1/2W	01121	EB 1051	2	
0687-2211	R:FXD COMP 220 OHM 10% 1/2W	01121	EB 2211	1	
0687-2221	R:FXD COMP 2.2K OHM 10% 1/2W	01121	EB 2221	3	
0687-2241	R:FXD COMP 220K OHM 10% 1/2W	01121	EB 2241	1	
0687-3331	R:FXD COMP 33K OHM 10% 1/2W	01121	EB 3331	1	
0687-3931	R:FXD COMP 39K OHM 10% 1/2W	01121	EB 3931	1	
0687-4741	R:FXD COMP 470K OHM 10% 1/2W	01121	EB 4741	6	
0687-6831	R:FXD COMP 68K OHM 10% 1/2W	01121	EB 6831	1	
0690-1241	R:FXD COMP 120K OHM 10% 1W	01121	GB 1241	2	
0690-1541	R:FXD COMP 150K OHM 10% 1W	01121	GB 1541	1	
0690-1841	R:FXD COMP 180K OHM 10% 1W(8614B ONLY)	01121	GB 1841	1	
0690-2241	R:FXD COMP 220K OHM 10% 1W(8616B ONLY)	01121	GB 2241	1	
0690-2741	R:FXD COMP 270K OHM 10% 1W	01121	GB 2741	3	
0690-3341	R:FXD COMP 330K OHM 10% 1W	01121	GB 3341	1	
0690-3911	R:FXD COMP 390 OHM 10% 1W	01121	GB 3911	2	
0690-3941	R:FXD COMP 390K OHM 10% 1W	01121	GB 3941	1	
0693-1531	R:FXD COMP 15K OHM 10% 2W	01121	HB 1531	1	
0693-3301	R:FXD COMP 33 OHM 10% 2W	01121	HB 3301	1	
0693-4701	R:FXD COMP 47 OHM 10% 2W	01121	HB 4701	1	
0727-0259	R:FXD DEPC 900K OHM 1% 1/2W(8614B ONLY)	19701	DC 1/2A	1	
0727-0267	R:FXD DEPC 980K OHM 1% 1/2W(8614B ONLY)	19701	DC 1/2C	1	
0727-0280	R:FXD DEPC 1.2 MEGOHM 1% 1/2W(8616B ONLY	19701	CF 1/2	1	
0727-0282	R:FXD DEPC 1.5 MEGOHM 1% 1/2W(8616B ONLY	19701	DC 1/2-1.5M-1%	1	
0730-0037	R:FXD DEPC 19K OHM 1% 1W	19701	DC 1	1	
0730-0062	R:FXD DEPC 80K OHM 1% 1W	19701	DC 1	1	
0758-0052	R:FXD MET OX 91K OHM 5% 1/2W	07115	C20	1	
0761-0017	R:FXD MET OX 300K OHM 5% 1W	07115	C32	1	

See introduction to this section

Table 6-2. **Replaceable Parts** (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	
0764-0028	R:FXD MET OX 100K OHM 5% 2W	07115	C-42S	1	
0770-0009	R:FXD MET OX 47K OHM 5% 4W(8614B ONLY)	07115	LP1-4	1	
0770-0013	R:FXD MET OX 56K OHM 5% 4W(8616B ONLY)	07115	LP1-4	1	
0773-0005	R:FXD MET OX 12K OHM 5% 5W	07115	LP1-5	1	
0813-0030	R:FXD WW 3.9 OHM 10% 3W	75042	BWH	1	
0839-0020	THERMISTOR:DISC 100 OHM 10%	24446	1D 753	1	
1200-0043	INSULATOR:TRANSISTOR(Q1)	71785	294457	1	
1200-0053	SOCKET:TUBE 7 PIN	71785	111-51-11-069	3	
1200-0062	SOCKET:TUBE 9 PIN	71785	121-51-11-060	7	
1200-0088	INSULATOR:DIODE(CR1)	71785	293201	2	
1210-0003	BRACKET:CAPACITOR(C205)	28480	1210-0003	1	
1250-0017	CONTACT:CENTER PIN,FEMALE	91737	5090-20	2	
1250-0141	BODY:CLAMPING	91737	8124-4	2	
1250-0142	NUT:CLAMP	91737	88C-14	2	
1250-0143	WASHER:SHOULDERED	91737	88C-28	2	
1250-0144	BODY:CONNECTOR(P/O PROBE CONNECTOR ASSY.	91737	8124A-5	2	
1250-0145	GASKET:V GROOVE	91737	88C-35	2	
1250-0146	WASHER:FLAT	91737	88C-31	2	
1250-0147	NUT:RETAINING	91737	8124-14	2	
1250-0148	WASHER:INSULATING	91737	8124B-25	2	
1250-0160	CONNECTOR:BNC FEMALE	28480	1250-0160	2	
1251-0011	CONNECTOR:FEMALE 4 CONTACT	75173	S304AB	1	
1251-0053	CONNECTOR,TAPER,FEMALE(TEST POINT)	0000F	13A009-2	1	
1251-0148	CONNECTOR:AC POWER,3 PIN MALE	60427	H-1061 1G-3L	1	
1400-0071	CLAMP:TUBE FOR P.C. SOCKETS	28480	1400-0071	2	
1450-0039	LIGHT:INDICATOR NE-2H NEON	08717	859-R-5	1	
1490-0030	STAND:TILT	28480	1490-0030	1	
1520-0001	MOUNTING PLATE:CAPACITOR C1	56137	GRADE XP	1	
1520-0002	MOUNTING PLATE:CAPACITOR C2,C3,C4, C205	56137	OBD	4	
1850-0064	TRANSISTOR:GERMANIUM PNP 2N1183	02735	2N1183	1	
1850-0098	TRANSISTOR:GERMANIUM PNP	98925	CQT-794	1	
1853-0001	TRANSISTOR:SILICON PNP	07263	S-3251	2	
1901-0025	SEMICON DEVICE:DIODE SILICON	28480	1901-0025	4	
1901-0030	SEMICON DEVICE:DIODE SILICON	02735	35434	4	
1901-0032	SEMICON DEVICE:DIODE SILICON 1N3209	04713	1N3209	1	
1902-0031	SEMICON DEVICE:DIODE ZENER	28480	1902-0031	1	
1902-0032	SEMICON DEVICE:DIODE ZENER	28480	1902-0032	1	
1902-0057	SEMICON DEVICE:DIODE SILICON	01281	PS8754	1	
1921-0005	ELECTRON TUBE:TRIODE 6C4	33173	6C4	1	
1921-0014	ELECTRON TUBE:TRIODE 7233	33173	7233	2	
1923-0030	ELECTRON TUBE:6CL6	86684	6CL6	1	
1923-0046	ELECTRON TUBE:6EJ7	73445	6EJ7	1	
1932-0030	ELECTRON TUBE:DUAL TRIODE 12AX7A	86684	12AX7A	2	
1932-0048	ELECTRON TUBE:EIA TYPE 12AZ7A	33173	12AZ7A	1	
1940-0001	ELECTRON TUBE:5651	86684	5651	1	
1940-0007	ELECTRON TUBE:OB2	86684	OB2	1	
1950-0003	ELECTRON TUBE:KLYSTRON 5837(8614B ONLY)	82219	#5837	1	
1950-0018	ELECTRON TUBE:KLYSTRON 5836(8616B ONLY)	82219	5836	1	
2100-0027	R:VAR COMP 10K OHM 10% LIN 2W(8616B ONLY)	28480	2100-0027	1	
2100-0028	R:VAR COMP 50K OHM 10% LIN 2W(8614B ONLY)	28480	2100-0028	1	

See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	
2100-0029	R:VAR COMP 250K OHM 10% LIN 2W	28480	2100-0029	1	
2100-0044	R:VAR COMP 50K OHM 10% LIN 2W	01121	JA1N056 S503UZ	1	
2100-0092	R:VAR COMP 10K OHM 20% LIN(8614B ONLY)	28480	2100-0092	1	
2100-0093	R:VAR COMP 20K OHM 20% LIN (8616B ONLY)	28480	2100-0093	2	
2100-0094	R:VAR COMP 50K OHM 30% LIN	28480	2100-0094	1	
2100-0317	R:VAR WW 2 OHM 20% LIN 3W	28480	2100-0317	1	
2100-0399	R:VAR WW 100K OHM	28480	4-6054	1	
2100-0401	TRACKING POT ROTOR	28480	4-6055	1	
2100-0402	TRACKING POT STATOR	28480	2100-0402	1	
2100-0411	R:VAR COMP 2 X 7K OHM 10% LIN 1/2W	71590	MODEL 2	1	
2110-0033	FUSE:.75A,250V (230VOLT OPERATION)	75915	F02GR750A	1	
2110-0043	FUSE:1.5A,250V (115VOLT OPERATION)	75915	31201.5	1	
3101-0033	SWITCH:SLIDE DPDT (115/230)	42190	4633	1	
3101-0042	SWITCH:PUSHBUTTON SPST	28480	3101-0042	1	
3101-0043	SWITCH:PUSHBUTTON DPDT	28480	3101-0043	4	
3102-0009	SWITCH:MICRO SPDT 5A	80207	USMW	1	
5000-0051	PLATE:FLUTED ALUMINUM	28480	5000-0051	2	
5000-0244	LABEL:FM	28480	5000-0244	1	
5000-0245	LABEL:PULSE	28480	5000-0245	1	
5000-0246	LABEL:SQUARE WAVE	28480	5000-0246	1	
5000-0247	LABEL:RF	28480	5000-0247	1	
5000-0248	LABEL:LINE	28480	5000-0248	1	
5020-0306	COUPLING NUT:P/O PLUG TYPE N CONNECTOR	28480	5020-0306	1	
5000-0738	COVER:SIDE	28480	5000-0738	2	
5000-0739	COVER:SIDE	28480	5000-0739	2	
5040-0201	BEZEL:COUNTER(ATTEN)	28480	5040-0201	1	
5040-0202	BEZEL:COUNTER(FREQ)	28480	5040-0202	1	
5040-0417	CLAMP HOLDER:9 PIN FOR XV101,XV102	28480	5040-0417	2	
5060-0732	FRAME	28480	5060-0732	2	
5060-0740	COVER:TOP	28480	5060-0740	1	
5060-0752	COVER:BOTTOM	28480	5060-0752	1	
5060-0763	ASSY,SIDE HANDLE	28480	5060-0763	2	
5060-0766	RETAINER, 5 1/4 HANDLE	28480	5060-0766	2	
5060-0767	ASSY,FOOT-FULL MOD.	28480	5060-767	5	
5060-0775	KIT:RACK MOUNT	28480	5060-0775	1	
8120-0078	CABLE:POWER	28480	8120-0078	1	
08614-008	PANEL:RECESSED REAR	28480	08614-008	1	
08614-017	CHASSIS,MAIN	28480	08614-017	1	
08614-018	PANEL:FRONT	28480	08614-018	1	
08614-227	PLUG,TYPE N CONNECTOR	28480	08614-227	1	
08614-260	CAM,FREQUENCY	28480	08614-260	1	
08614-261	CAM,LENGTH	28480	08614-261	1	
08614-264	ASSEMBLY,WIPER	28480	08614-264	1	
08614-282	CONDUCTOR,CENTER	28480	08614-282	1	
08614-291	BLANK PRINTED CIRCUIT BOARD	28480	08614-291	1	
08614-611	ASSY:INTAKE AIR CLEANER	28480	08614-611	1	
08614-612	ASSEMBLY,SHIELDED FAN	28480	08614-612	1	
08614-614	PROBE ASSEMBLY(8614B ONLY)	28480	08614-614	1	
08614-615	CAVITY ASSEMBLY(8614B ONLY)	28480	08614-615	1	
08614-616	HIGH VOLTAGE BOARD(8614B ONLY)	28480	08614-616	1	
08614-617	WIRING HARNESS,BRANCHED AC	28480	08614-617	1	
08614-618	WIRING HARNESS,BRANCHED DC	28480	08614-618	1	
08616-003	PANEL:FRONT	28480	08616-003	1	
08616-605	PROBE ASSEMBLY(8616B ONLY)	28480	08616-605	1	
08616-606	CAVITY ASSEMBLY(8616B ONLY)	28480	08616-606	1	
08616-607	HIGH VOLTAGE BOARD(8616B ONLY)	28480	08616-607	1	
9100-0176	TRANSFORMER:POWER	28480	9100-0176	1	

See introduction to this section

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00334	Humidall Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordnit Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Fulton Co., Inc., Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04777	Automatic Electric Sales Corp.	Northlake, Ill.
04796	Sequoia Wire & Cable Co.	Redwood City, Calif.
04870	P. M. Motor Company	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metropolitan Telecommunications Corp., Metro Cap. Division	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06751	U. S. Semcor Division of Nuclear Corp. of America	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07490	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada.
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co. Phoenix Div.	Phoenix, Ariz
08752	CBS Electronics Semiconductor Operations Div. of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Ram	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09664	The Bristol Co.	Waterbury, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Tri-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermoloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
14099	Semi-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
15909	The Daven Co.	Livingston, N.J.
16688	De Jur Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division Nela Park,	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
53742	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth 1, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71285	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C. P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72092	Extel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
71707	Coto Coil Co., Inc.	Providence, R.I.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp., Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H. M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Philips Co, Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	So. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif.
77250	Phoeli Mfg. Co.	Chicago, Ill.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association. Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W.L. Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
81349	Military Specification	.....
81415	Witkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.

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Revised: March 9, 1964

From: F.S.C. Handbook Supplements
H4-1 Dated March 1963
H4-2 Dated March 1962

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

Code No.	Manufacturer	Address
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronis, Inc.	New York, N.Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	Seattle, Wash.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Inc. Co.	Oakland, Calif.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers', Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Ill.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith Inc.	Port Monmouth, N. J.
93929	G. V. Controls	Livingston, N. J.
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94222	Southco Div. of S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordas Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp of Calif.	Newbury Park, Calif.

Code No.	Manufacturer	Address
	THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.	
C0000	JFD Electronics Corp.	Van Nuys, Calif.
G0000	Tranex Company	Mountain View, Calif.
I0000	Western Devices, Inc.	Inglewood, Calif.
J0000	Winchester Electronics, Inc.	Santa Monica, Calif.
0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000O	U.S.A. Common	Any supplier of U.S.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000T	Texas Instruments, Inc. Metals and Controls Div.	Versailles, Ky.
0000U	Tower Mfg. Corp.	Providence, R.I.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000X	Spruce Pine Mica Co.	Spruce Pine, N.C.
0000Y	Midland Mfg. Co. Inc.	Kansas City, Kans.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000AB	ETA	England
000AC	Indiana General Corp., Elect. Div.	Indiana
000AD	Curtis Instrument Inc.	Mt. Kisco, N.Y.
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CC	Computer Diode Corp.	Lodi, N.J.
000EE	A. Williams Manufacturing Co.	San Jose, Calif.
000GG	Goshen Die Cutting Service	Goshen, Ind.
000HH	Rubbercraft Corp.	Torrance, Calif.
000II	Birtcher Corporation, Industrial Division	Monterey Park, Calif.
000KK	Amatom	New Rochelle, N.Y.
000LL	Avery Label	Monrovia, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Manufacturing Co.	San Jose 27, Calif.
000PP	Atohm Electronics	Sun Valley, Calif.
000QQ	Coiltron	Oakland, Calif.
000RR	Radio Industries	Des Plaines, Ill.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000WW	California Eastern Lab.	Burlingame, Calif.
000XX	Methode Electronics, Inc.	Chicago 31, Ill.
000YY	S.K. Smith Co.	Los Angeles 45, Calif.

00015-35
Revised: March 9, 1964

From: F.S.C. Handbook Supplements
H4-1 Dated March 1963
H4-2 Dated March 1962

WARRANTY CLAIM AND ADJUSTMENT PROCEDURE

for microwave tubes supplied by the
HEWLETT-PACKARD COMPANY
for use in hp instruments

The procedure described below is for use within the United States. For warranty claims arising outside the U.S.A., before returning the tube, fill out the form on the reverse side and send it with a request for shipping instructions to your local hp office or:

(in Western Europe)

Hewlett-Packard S.A.
54 Route des Acacias
Geneva, Switzerland
Telephone: (022) 42.81.50
Telex: 2.24.86
Cable: HEWPACKSA

(Rest of World)

Hewlett-Packard Co.
International Marketing Dept.
1501 Page Mill Road
Palo Alto, California, 94304, U.S.A.
Telephone: (415) 326-7000
Telex: 033811
Cable: HEWPACK

Microwave tubes supplied by the Hewlett-Packard Company, either as original or replacement, for use in hp instruments are actually warranted by the tube manufacturer and not by hp. However, hp will process warranty claims for you, and will promptly pass on all allowances granted by the tube manufacturer.

In the event that your tube is found to be repairable, the tube manufacturer reserves the right to repair and return the tube in lieu of issuing pro-rata credit.

For your convenience, warranty claims for all microwave tubes supplied by the Hewlett-Packard Company may be made on this single form; merely fill out the information on the reverse side and return this form, along with the defective tube, to your hp field office or to Hewlett-Packard. Please be sure each space on the form is filled in--lack of complete information may delay processing of your claim.

Each tube manufacturer has his own warranty policy. Copies of individual Conditions of Warranty are available from your hp field office or from the Hewlett-Packard Company.

SHIPPING INSTRUCTIONS

The following instructions are included to aid you in preventing damage in transit. Package your tube carefully--no allowance can be made on broken tubes.

1. Carefully wrap tube in 1/4-inch thick "kimpack", cotton batting, or other soft padding material. Cable assemblies and other accessories not rigidly mounted to the tube should be padded and wrapped separately to prevent damage to the tube during shipment.
2. Wrap the above in heavy kraft paper.
3. Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.
4. Surround the tube with at least 2 inches of shock absorbing material. Be certain that the packing is tight all around the tube.
5. Tubes returned from outside the continental United States should be packed in a wooden box.
6. Mark container FRAGILE and ship prepaid via Air freight or Railway Express. Do not ship via Parcel Post or Air Parcel Post since experience has shown that fragile items are more apt to be damaged when shipped by these means.

Note

Tubes with permanent magnets can interfere with magnetic compasses.
For air shipment plainly mark container: "MAGNETIZED MATERIAL"

Tubes returned to the Hewlett-Packard Company should be addressed to:

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California, 94306, U.S.A.
Telephone: (415) 326-3950
TWX No. (415) 492-9363

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MICROWAVE TUBE WARRANTY CLAIM
INFORMATION FORM

IMPORTANT: Please answer all questions fully -- insufficient information may delay processing of your claim.

FROM: (Tube Owner)

Company _____

Address _____

_____

_____

Tube type _____

Tube serial No. _____

Tube mfr. _____

Use in hp Model _____

Instrument serial no. _____

Tube is Original ( ) or Replacement ( )

Date tube received _____

Date first tested _____

Date placed in service _____

Date of failure _____

Date _____

FOR FURTHER INFORMATION CONTACT:

Name _____

Title _____

Company _____

Address _____

_____

Tube purchased from _____

_____

On P. O. number _____

Hours use per day (average) _____

Number of days in service _____

Total hours filament operation _____

SYMPTOMS: (Please describe conditions prior to and at time of failure, along with description of tube's defect, if known) _____

_____

_____

_____

Were there other circuit component failures at time of failure? Which ones?

_____

_____

Signature _____

Title _____

10/15/62
01153-3

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CENTRAL AND SOUTH AMERICA

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Hewlett-Packard Argentina
S.A.C.e.I.
Lavalle 1171 - 3°
Buenos Aires

Lutz, Ferrando y Cia. S. A.
Florida 240 (R.5)
Buenos Aires
Tel: 46-7241, 46-1635
Cable: OPTICA Buenos Aires

BRAZIL
Hewlett-Packard Do Brasil
I.e.C. Ltda.
Rua Cel. Oscar Porto, 691
Sao Paulo - 8, SP
Tel: 71-1503
Cable: HEWPAK Sao Paulo

Hewlett-Packard Do Brasil
I.e.C. Ltda.
Avenida Franklin Roosevelt 84-
grupo 203
Rio de Janeiro, ZC-39, GB
Tel: 32-9733
Cable: HEWPAK Rio de Janeiro

CHILE
Hector Calcagni P.
Casilla 13942
Estado 215 - Oficina 1016
Santiago
Tel: 31-890, 490-505

COLOMBIA
Instrumentacion
Henrik A. Langebaek & Cia. Ltda.
Carrera 7 # 48-59
Apartado Aéreo 6287
Bogota, 1. D.E.
Tel: 45-78-06, 45-55-46
Cable: AARIS Bogota

COSTA RICA
Lic. Alfredo Gallegos Gurdián
Apartado 3243
San José
Tel: 21-86-13
Cable: GALGUR San José

ECUADOR
Laboratorios de Radio-Ingenieria
Calle Guayaquil 1246
Post Office Box 3199
Quito
Tel: 12496
Cable: HORVATH Quito

EL SALVADOR
Electrónica
Apartado Postal 1589
27 Avenida Norte 1133
San Salvador
Tel: 25 74 50
Cable: ELECTRONICA San Salvador

GUATEMALA
Olander Associates Latin America
Apartado 1226
7a. Calle, 0-22, Zona 1
Guatemala City
Tel: 22812
Cable: OLALA Guatemala City

MEXICO
Hewlett-Packard Mexicana, S.A.
de C.V.
Apartado Postal 12-832
Eugenia 408, Dept. 1
Mexico 12, D.F.
Tel: 43-03-79, 36-08-78

NICARAGUA
Roberto Terán G.
Apartado Postal 689
Edificio Terán
Managua
Tel: 3451, 3452
Cable: ROTERAN Managua

PANAMA
Electronica Balboa, S.A.
P.O. Box 4929
Ave. Manuel Espinosa No. 13-50
Bldg. Alina
Panama City
Tel: 30833
Cable: ELECTRON Panama City

PERU
Fernando Ezeta B.
Avenida Petit Thouars 4719
Miraflores
Casilla 3061
Lima
Tel: 50346
Cable: FEPERU Lima

PUERTO RICO
San Juan Electronics, Inc.
P.O. Box 5167
Ponce de Leon 154
Pda. 3-Pta. de Tierra
San Juan, P.R. 00906
Tel: (174) 725-3342
Cable: SATRONICS San Juan

URUGUAY
Pablo Ferrando S.A.
Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
Cable: RADIUM Montevideo

VENEZUELA
Hewlett-Packard De Venezuela C.A.
Edificio Arisán-Of. 4
Avda. Francisco de Miranda
Chacaito
Caracas
Tel: 71.88.05
Cable: HEWPACK Caracas
Mailing Address: Apartado del
Este 10934 Caracas

FOR AREAS NOT LISTED,
CONTACT:
Hewlett-Packard Inter-Americas
1501 Page Mill Road
Palo Alto, California 94304
Tel: (415) 326-7000
TWX: 910-373-1267
Telex: 034-8461
Cable: HEWPACK Palo Alto

UNITED STATES

ALABAMA
P.O. Box 4207
2003 Byrd Spring Road S.W.
Huntsville 35802
Tel: (205) 881-4591
TWX: 810-726-2204

ARIZONA
3009 North Scottsdale Road
Scottsdale 85251
Tel: (602) 945-7601
TWX: 910-950-1282

5737 East Broadway
Tuscon 85716
Tel: (602) 298-2313
TWX: 910-952-1162

CALIFORNIA
3939 Lankershim Boulevard
North Hollywood 91604
Tel: (213) 877-1282
TWX: 910-499-2170

1101 Embarcadero Road
Palo Alto 94303
Tel: (415) 327-6500
TWX: 910-373-1280

2591 Carlsbad Avenue
Sacramento 95821
Tel: (916) 482-1463
TWX: 910-367-2092

1055 Shafter Street
San Diego 92106
Tel: (714) 223-8103
TWX: 910-335-2000

COLORADO
7965 East Prentice
Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

CONNECTICUT
508 Tolland Street
East Hartford 06108
Tel: (203) 289-9394
TWX: 710-425-3416

111 East Avenue
Norwalk 06851
Tel: (203) 853-1251
TWX: 710-468-3750

DELAWARE
3941 Kennett Pike
Wilmington 19807
Tel: (302) 655-6161
TWX: 510-666-2214

FLORIDA
P.O. Box 545
Suite 106
9999 N.E. 2nd Avenue
Miami Shores 33153
Tel: (305) 758-3626
TWX: 810-848-7262

P.O. Box 20007
Herndon Station 32814
621 Commonwealth Avenue
Orlando
Tel: (305) 841-3970
TWX: 810-850-0113

P.O. Box 8128
Madeira Beach 33708
410 150th Avenue
St. Petersburg
Tel: (813) 391-0211
TWX: 810-863-0366

GEORGIA
P.O. Box 28234
2340 Interstate Parkway
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

ILLINOIS
5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
4002 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
TWX: 810-341-3263

LOUISIANA
P.O. Box 856
1942 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

MARYLAND
6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-0850

P.O. Box 727
Twinbrook Station 20851
12303 Twinbrook Parkway
Rockville
Tel: (301) 427-7560
TWX: 710-828-9684

MASSACHUSETTS
32 Hartwell Road
Lexington 02173
Tel: (617) 861-8960
TWX: 710-332-0382

MICHIGAN
24315 Northwestern Highway
Southfield 48075
Tel: (313) 353-9100
TWX: 810-232-1532

MINNESOTA
2459 University Avenue
St. Paul 55114
Tel: (612) 645-9461
TWX: 910-563-3734

MISSOURI
9208 Wyoming Place
Kansas City 64114
Tel: (816) 333-2445
TWX: 910-771-2087

2812 South Brentwood Blvd.
St. Louis 63144
Tel: (314) 644-0220
TWX: 910-760-1670

NEW JERSEY
W. 120 Century Road
Paramus 07652
Tel: (201) 265-5000
TWX: 710-990-4951

NEW MEXICO
P.O. Box 8366
Station C
6501 Lomas Boulevard N.E.
Albuquerque 87108
Tel: (505) 255-5586
TWX: 910-989-1665

156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
TWX: 910-983-0550

NEW YORK
1702 Central Avenue
Albany 12205
Tel: (518) 869-8462
TWX: 710-441-8270

1219 Campville Road
Endicott 13764
Tel: (607) 754-0050
TWX: 510-252-0890

82 Washington Street
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012

39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

1025 Northern Boulevard
Roslyn, Long Island 11576
Tel: (516) 869-8400
TWX: 510-223-0811

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

NORTH CAROLINA
P.O. Box 5188
1923 North Main Street
High Point 27262
Tel: (919) 882-6873
TWX: 510-926-1516

OHIO
5579 Pearl Road
Cleveland 44129
Tel: (216) 884-9209
TWX: 810-421-8500

3460 South Dixie Drive
Dayton 45439
Tel: (513) 298-0351
TWX: 810-459-1925

OKLAHOMA
2919 United Founders Boulevard
Oklahoma City 73112
Tel: (405) 848-2801
TWX: 910-830-6862

OREGON
Westhills Mall, Suite 158
4475 S.W. Scholls Ferry Road
Portland 97225
Tel: (503) 292-9171
TWX: 910-464-6103

PENNSYLVANIA
2500 Moss Side Boulevard
Monroeville 15146
Tel: (412) 271-0724
TWX: 710-797-3650

144 Elizabeth Street
West Conshohocken 19428
Tel: (215) 248-1600, 828-6200
TWX: 510-660-8715

TEXAS
P.O. Box 7166
3605 Inwood Road
Dallas 75209
Tel: (214) 357-1881
TWX: 910-861-4081

P.O. Box 22813
4242 Richmond Avenue
Houston 77027
Tel: (713) 667-2407
TWX: 910-881-2645

GOVERNMENT CONTRACT OFFICE
225 Billy Mitchell Road
San Antonio 78226
Tel: (512) 434-4171
TWX: 910-871-1170

UTAH
2890 South Main Street
Salt Lake City 84115
Tel: (801) 486-8166
TWX: 910-925-5681

VIRGINIA
P.O. Box 6514
2111 Spencer Road
Richmond 23230
Tel: (703) 282-5451
TWX: 710-956-0157

WASHINGTON
433-108th N.E.
Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2303

FOR U.S. AREAS NOT LISTED:
Contact the regional office nearest you: Atlanta, Georgia . . . North Hollywood, California . . . Paramus, New Jersey . . . Skokie, Illinois. Their complete addresses are listed above.

CANADA

ALBERTA
Hewlett-Packard (Canada) Ltd.
11745 Jasper Avenue
Edmonton
Tel: (403) 482-5561
TWX: 610-831-2431

BRITISH COLUMBIA
Hewlett-Packard (Canada) Ltd.
304-1037 West Broadway
Vancouver 9
Tel: (604) 731-5301
TWX: 610-922-5059

NOVA SCOTIA
Hewlett-Packard (Canada) Ltd.
7001 Mumford Road
Suite 356
Halifax
Tel: (902) 455-0511
TWX: 610-271-4482

ONTARIO
Hewlett-Packard (Canada) Ltd.
880 Lady Ellen Place
Ottawa 3
Tel: (613) 722-4223
TWX: 610-562-1952

Hewlett-Packard (Canada) Ltd.
1415 Lawrence Avenue West
Toronto
Tel: (416) 249-9196
TWX: 610-492-2382

QUEBEC
Hewlett-Packard (Canada) Ltd.
275 Hymus Boulevard
Pointe Claire
Tel: (514) 697-4232
TWX: 610-422-3022
Telex: 01-20607

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ELECTRONIC INSTRUMENTATION SALES AND SERVICE
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AUSTRIA
Unilabor GmbH
Wissenschaftliche Instrumente
Rummelhardtgasse 6/3
P.O. Box 33
Vienna IX/71
Tel: 426 181
Cable: LABORINSTRUMENT Vienna

BELGIUM
Hewlett-Packard Benelux S.A.
348 Boulevard du Souverain
Brussels 16
Tel: 72 22 40
Cable: PALOBEN Brussels
Telex: 23 494

DENMARK
Hewlett-Packard A/S
Langebjerg 6
2850 **Naerum**
Tel: 01 80 40 40
Cable: HEWPACK AS
Telex: 66 40

FINLAND
Hewlett-Packard Oy
Gyldenintie 3
Helsinki 20
Tel: 67 35 38
Telex: 12-1563

FRANCE
Hewlett-Packard France
150 Boulevard Masséna
75 Paris 13e
Tel: 707 97 19
Cable: HEWPACK Paris
Telex: 25048

Hewlett-Packard France
4, quai des Etroits
69 **Lyon** 6e
Tel: 52 35 66
Telex: 31617

GERMANY
Hewlett-Packard Vertriebs-GmbH
Lietzenburger Strasse 30
1 Berlin W.30
Tel: 24 86 36

Hewlett-Packard Vertriebs-GmbH
Herrenberger Strasse 110
703 **Böblingen**, Württemberg
Tel: 07031-6971
Cable: HEPAG Böblingen
Telex: 72 65 739

Hewlett-Packard Vertriebs-GmbH
Achenbachstrasse 15
4 **Düsseldorf** 1
Tel: 68 52 58/59
Telex: 85 86 533

Hewlett-Packard Vertriebs-GmbH
Kurhessenstrasse 95
6 **Frankfurt** 50
Tel: 52 00 36
Cable: HEWPACKSA Frankfurt
Telex: 41 32 49

Hewlett-Packard Vertriebs-GmbH
Beim Strohhause 26
2 **Hamburg** 1
Tel: 24 05 51/52
Cable: HEWPACKSA Hamburg
Telex: 21 53 32

Hewlett-Packard Vertriebs-GmbH
Reginfriedstrasse 13
8 **Munich** 9
Tel: 69 51 21/22
Cable: HEWPACKSA Munich
Telex: 52 49 85

GREECE
Kostas Karayannis
18, Ermou Street
Athens 126
Tel: 230 301
Cable: RAKAR Athens

IRELAND
Hewlett-Packard Ltd.
224 Bath Road
Slough, Bucks, England
Tel: Slough 28406-9, 29468-9
Cable: HEWPIE Slough
Telex: 84413

ITALY
Hewlett-Packard Italiana S.p.A.
Viale Lunigiana 46
20125 **Milan**
Tel: 69 15 84
Cable: HEWPACKIT Milan
Telex: 32046

Hewlett-Packard Italiana S.p.A.
Palazzo Italia
Piazza Marconi 25
00144 **Rome-Eur**
Tel: 591 25 44
Cable: HEWPACKIT Rome

NETHERLANDS
Hewlett-Packard Benelux N.V.
De Boelelaan 1043
Amsterdam, Z.2
Tel: 42 77 77
Cable: PALOBEN Amsterdam
Telex: 13 216

NORWAY
Hewlett-Packard Norge A/S
Nesveien 13
Hasium
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Cable: HEWPACK Oslo
Telex: 6621

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